TRACKTALK
RAILWAYS COMMUNICATIONS E-ZINE

MACHINE-TO-MACHINE TECHNOLOGY – THE KEY TO OPERATING EXCELLENCE

The development of machine-to-machine technology means that today almost any rail asset can talk to another wirelessly. Connecting devices is an increasingly affordable and reliable means of monitoring the performance of almost any facet of rail operation, providing remote access to data in real-time and allowing pre-emptive maintenance.

M2M and automation offer a step-change in operational capability and performance, but they also require cultural change, and rail operators are adapting their asset management processes to fully exploit these technologies.

This issue of TrackTalk focuses on how automation, M2M, and intelligent infra-structure can optimise operations, bringing together four distinguished perspectives on this topic from industry experts.

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CONTACT: olivier.andre@alcatel-lucent.com

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LOOKING FORWARD WITH DRIVERLESS OPERATION

BY: JARRETT WALKER, PRINCIPAL CONSULTANT, MCCORMICK RANKIN CAGNEY AND BLOGGER, WWW.HUMANTRANSIT.ORG

HIGHLIGHTS

- **The ability to increase service frequency and flexibility is a key social benefit of automation**
- **It makes public transport a more convenient option. With more trains, passengers get more freedom and are more relax.**
- **Driver redeployment is a key consideration when planning migration to unattended operation**

Whether it's the panoramic views of the city or the feeling that you're almost driving yourself, there's something intrinsically satisfying about occupying the front seat of a driverless metro train, where you enjoy a view once reserved exclusively for the driver. Automated metros are nothing new, and every year dozens of new automated lines open in cities around the world, yet for passengers they retain much of that novelty value.

Equally however, the absence of a driver in the cab remains a source of anxiety to some users, particularly on new systems. "The fear of automation, and the desire to know that a visible human being is in charge, are understandable traits of the 20th century transit rider," explains Jarrett Walker, Principal Consultant with Australian transport consultancy McCormick Rankin Cagney and editor of the Human Transit blog (www.humantransit.org). "On a bus, the driver is obviously in charge of safety, security, and fare enforcement, so you come to rely on that person. You usually don't interact with a rail transit driver, though it may feel good to wave at him or her when you get on or off."

Walker cites the role of the driver on the BART system in San Francisco as an example of how passengers become accustomed to automation. "When a BART train stops at a station, the driver leans out of the cab and faces backwards along the train, checking that the doors are closed, but also that the train starts moving with the driver still in that position, not looking out in front," he says. "This gradually helps customers accept that the driver isn't really driving at all, that most of the driver's tasks are already handled by automation. In fact even the remaining operator's tasks – closing doors and watching for objects falling on the track – are now routinely automated in other systems."

"The only way you overcome generalized anxiety about driverless service is through a combination of information and patience. But enough systems are running now that you can also respond with data. In Vancouver they have been successfully using driverless technology for 25 years without compromising safety and security."

Reminding passengers that **a human presence remains in place has been key to tackling anxiety on driverless metros.** On Vancouver's SkyTrain network, passengers can contact staff at any time via intercoms which connect directly to the operations center. "You call the operations center rather than the driver," Walker explains. "But in return you reach someone who's more likely to know what's going on, or be able to summon help efficiently." In addition, larger stations are staffed and employees are clearly visible.

In order to achieve high availability and optimize safety, most automated metro lines are equipped with platform screen doors. The reasons for this are graphically demonstrated by the project to automate Paris Metro Line 1, which will be completed later this year and is one of the first metro lines in the world to be converted to Unattended Train Operation (UTO). Prior to the transition, Paris Transport Authority (RATP) recorded 3275 incidents on Line 1 in a single year, of which 72% were caused by passengers. On Line 14, which is already automated with platform screen doors, just 16% of the 243 incidents recorded were caused by passengers.

FREQUENCY – THE KEY TO THE CITY

What is the primary justification for automating trains? Frequency. **Automation allows for increased services at minimal additional cost,** taking the driver out of the cab and severing the link between frequency and labor cost. The enhanced acceleration and braking characteristics

"The only way you overcome generalized anxiety about driverless service is through a combination of information and patience. But enough systems are running now that you can also respond with data."

of driverless trains and the elimination of the human margin of error allows trains to run closer together, which means existing rolling stock and infrastructure assets can be used more intensively. Furthermore, it gives the operator the flexibility to operate services economically at times when demand is low, and increase capacity in peak periods or during special events.

"It's crucial to note that extreme frequency requires control-center operation to some degree, even if there's a driver in the cab," says Walker. "Headways of 1-2 minutes generally require Automated Train Control. At such high frequency, removing the "human factor" of driver operations yields a smoother and more reliable service."

These attributes have an important social impact. Access to higher-frequency metro services changes the role of public transport, making it a more convenient option. **"Frequency is freedom, it's that simple,"** Walker says. "In transport, we experience freedom mainly as spontaneity. Can we move around the city freely, changing plans on a whim? Do we have to worry about getting home if we go to an evening event whose ending time isn't definite? If you want a city to be vibrant for 18-24 hours a day, you need very high frequency services late into the evening. If you have an employee on every train, you will always be under pressure to cut off-peak frequency when the trains aren't as full, particularly when budgets are constrained. Driverless metros remove that pressure, so **it's economic to run frequently very late, even when ridership is low.** Vancouver's driverless SkyTrain lines run frequently all the time, and on main portions you'll rarely wait six minutes, even at 11pm."

High frequency also means passengers enjoy a less stressful journey. "On a line that runs every 15 minutes or less, the experience of entering a station almost always raises your heart rate," says Walker. "Is that whooshing sound a train that I'm about to miss? Should I hurry up just in case? In Vancouver, you can go through the whole riding experience in a relaxed and even meditative state, because you know that if you miss the train, another will always be there in a moment. Some people rush habitually, but at such extreme frequency, it's really possible not to."

MOVING PEOPLE – WHAT HAPPENS TO THE DRIVERS?

The redeployment of drivers is one of the most contentious social issues associated with the conversion of metro lines to automatic operation. Typically on lines that have been converted to full UTO, drivers remain on the train to provide **a visible staff presence and coordinate any emergency response.** Such a major change in the role of the driver clearly requires careful consultation between stakeholders if it is to be implemented successfully.

In January a row erupted over comments made by the Mayor of London Boris Johnson, who said in a speech that "it is a fact that in a few weeks, anybody in this room could acquire the qualifications to supervise an Underground train." This was met with a furious response from the RMT union, which complained: "It is clear he is planning to sack thousands of tube drivers." The debate was somewhat premature, as Transport for London currently has no plans to introduce driverless trains, and Johnson was responding to a series of strikes that had disrupted large parts of the network, but, it illustrates a potential flashpoint that many cities planning to automate existing lines will need to consider.

Driverless operation is now an almost universal feature of new metro lines, and it is becoming a viable option for older lines. RATP estimates that despite the significant capital cost, the conversion of Paris Line 1 to **UTO will reduce operating costs by 10%, offering a 10-year return on the investment.** The benefits to the city in terms of more frequent and responsive services will be felt much sooner.

CONNECTING DEVICES – AN INTEGRATED APPROACH TO MACHINE-TO-MACHINE TECHNOLOGY

BY: YIRU ZHONG, SENIOR INDUSTRY ANALYST, FROST & SULLIVAN

HIGHLIGHTS

- **The range of potential railway applications for M2M technology is huge**
- **The role of different stakeholders in the value chain is evolving as the technology matures**
- **Deployment of M2M solutions can be incorporated into ICT procurement**

Machine-to-Machine (M2M) communications is expected to become a massive growth market for the communications industry over the next decade, and the increasing availability and capability of these technologies could have a profound impact on the way railways function.

The so-called Internet of Things is expected to **connect 15 billion devices by 2015,** demanding fresh approaches to communications business models, operations, processes and technologies. M2M can communicate real-time data on a host of different asset-monitoring functions, from wagon tracking for rail freight customers to air-conditioning performance on passenger trains. The technology can facilitate features such as smart metering, which allows train operators to accurately and remotely report energy consumption to infrastructure managers, so they receive an actual rather than an estimated bill. It can monitor infrastructure, allowing faults to be identified and dealt with before they disrupt operations.

The proliferation of wireless technologies such as RFID, Bluetooth and WiFi means devices can communicate over ranges from a few centimeters to thousands of kilometers. Combined with stable and versatile data services, the range of potential applications is immense.

"M2M is all about allowing machines to communicate, and it has evolved into an intelligent way of managing assets," explains Yiru Zhong, senior industry analyst for Frost & Sullivan. "It allows companies to use data in a meaningful manner for pre-emptive repairs and maintenance, reducing the human cost of these processes. In the case of the rail industry, the objective is bringing down the human cost of engineering, and the downtime of rolling stock. Removing the element of human error is an intangible benefit and one of the key economic drivers in adopting M2M systems, but there are other factors too, such as improving customer service."

A RAPIDLY-EVOLVING MARKET

Typically, telecoms service providers supply a wholesale account and a SIM card, together with a data rate and billing plan. Generally they have no knowledge of the service being considered and only the data provided, meaning they have become connection providers, excluded from service development and delivery.

However, a major upheaval is underway. The falling cost of M2M devices, coupled with widespread connectivity and the rapid evolution of the applications market are generating opportunities for service providers to enhance their role in the M2M value chain. Telecommunications companies (telcos) recognize the huge potential of the M2M market and are positioning themselves carefully to take full advantage of the emerging opportunities. "Two years ago the telcos tended to offer M2M solutions on a local basis and often in isolation," says Zhong. "However, since 2009, they have reorganized their individual M2M resources into a single centralized unit to achieve better coordination and scale, both in terms of R&D and service innovations. This is making deployment more economically viable and more accessible. The modules themselves are becoming cheaper and new technology companies are pushing for more capable modules, expanding the range of tasks M2M can perform. The evolution of modules from 2G to higher speed mobile networks means end users, including rail operators, have the option to deploy more M2M points for remote monitoring and other advanced applications, meaning they can receive pre-emptive intelligence for better decision making."

While the role of Telcos in the communications value chain is changing, so is that of other M2M stakeholders. Telecom vendors and service integrators now offer turnkey communications solutions that integrate M2M functionality into the railway network management system.

Most businesses recognize that IT and networking will be the most difficult part of M2M deployments and as a result, service providers play a key role in the M2M market, offering operational and business support systems to a variety

of rail industry customers. But would a rail operator be likely to hand over OSS/BSS functions, together with management of their M2M devices, to a telco or anyone else? "This is possible in future if the M2M component is packaged into the rail operator's overall ICT management," says Zhong. "Naturally rail operators have various requirements such as data responsibility and have desire to maintain control over their rail network assets. But, if we consider that there may well be a time in the future when the data transmitted among devices, tags and objects becomes too large, there will be a business need to offload this management to someone better at doing this, such as a telco or a service integrator."

No single player in the market is currently able to provide a complete M2M solution and as such the value chain comprises a variety of suppliers and providers, each specializing in different applications, devices, modules, and services. Furthermore, the lack of standards makes this value chain complex and creates interoperability issues. Often in business-critical areas, Tier 1 telcos will enter a bidding consortium as the connectivity partner, and would have some security/certified grades.

So what kind of tender might a rail operator use for procuring M2M solutions? "It is possible that the M2M component will come through a tender for overhauling ICT networks, and the M2M component comes with the connectivity part," says Zhong. "Without connectivity and integration into the company's systems, M2M benefits are not optimized."

CAPEX OR OPEX?

Another issue to be considered when developing a business case for M2M is whether the project is a capital expenditure or an operational one. "When M2M is deployed in a railway environment the primary objective is usually operational savings, but in some circumstances it might make more sense to pursue the project as a capital investment, Zhong explains. "For example, if a subsidy is available for projects that result in lower carbon emissions, you might go for hardware through a CAPEX solution. It really depends on the country and the operator's individual business requirements."

M2M solutions depend on distributed applications, which process millions of real-time transactions. This means they need comprehensive data management, processing and storage capabilities. **"The ability to customize data handling in line with customer requirements is important, because the customer needs control over how the data is used.** Part of the challenge of data management is that information often just sits in silos and often it is not easily shared between functions," says Zhong.

The remote nature of the devices also means on-site support may not be economical or even possible, and therefore support functions such as troubleshooting and upgrading need to be carried out remotely. This inevitably has an impact on a rail operator's network management capabilities. "There is a removal of task sending a worker out to investigate something, but with M2M and the subsequent data transmission, there is an opportunity to utilize data for analytics," says Zhong. "This makes for an improvement in the operations and maintenance process, which in turn improves decision-making, and this ultimately leads to an improved customer experience."

Realizing the full economic value of this technology requires new approaches to business models and management processes that could have a major impact on the way railways function. Operators such as Swiss Federal Railways are now looking closely at how the strengths of M2M can be harnessed through new advanced management systems to achieve higher levels of performance. Such is the versatility of M2M that its potential is largely limited by the customer's imagination.

"Realizing the full economic value of this technology requires new approaches to business models and management processes that could have a major impact on the way railways function."

SWISS FEDERAL RAILWAYS (SBB) – CUTTING COSTS AND STREAMLINING OPERATIONS

BY: JAN RICHARD, INNOVATION AND TECHNOLOGY MANAGER AT SWISS FEDERAL RAILWAYS (SBB)

HIGHLIGHTS

- **SBB is gradually introducing M2M technologies across its network in areas where technologies can improve efficiency and cut costs**
- **M2M is promoting a change in thinking at the railway from reactive to proactive management**
- **SBB is working to move away from remote M2M applications to develop a centralized management system capable of handling all types of architecture**

From timetable tools to operator management systems, route settings and all aspects of signaling, railways throughout the world are successfully utilizing Machine to Machine (M2M) technologies in all areas of operation.

Swiss Federal Railways (SBB) is no exception. The operator is using M2M innovations on 3039 km of lines across its network. And with the railway aiming to make **cost savings of up to 15%** from more efficient technologies by 2017-2018, there are significant plans in place to introduce further M2M solutions that will improve performance and efficiency over the next few years.

"Across the whole value chain, M2M is optimizing operations across our network," says Jan Richard, SBB's innovation and technology manager. "It was first introduced 20 years ago and since then we have gradually implemented it in all areas. We have done it in a very pragmatic way because rather than doing a full rollout over the entire network which would be very difficult and potentially disruptive we are doing it step by step when certain parts of the system are renewed. Technically it is working very well with a lot fewer failures at the substation."

SBB has not emphasized a single technology in a specific area of operations during this rollout, instead selecting M2M solutions that will bring efficiency savings and an improvement in operations. **Telecoms operations, fiber optic systems and overall operations are all areas where M2M is having a significant impact due to greater efficiency in management operations.** Inevitably though, SBB has, and continues to experience, significant challenges in this gradual rollout.

> "One example of where M2M is helping to improve operations is in point maintenance. If a point starts to become worn or faulty we can see that happening and can schedule maintenance to address the fault before it becomes a problem."

Richard says that one of the most difficult issues to overcome is the change in professional standard of employees required to operate and manage the new systems. As a result, **extensive training programs** have been introduced to help SBB's employees get up to speed while a number of new staff with the required skills has been hired.

Another major challenge is to **minimize traffic disruption** while the new systems are rolled out. "Rail traffic could potentially be greatly affected during this migration, which would not be good for the railway or for our customers," Richard says. "We therefore have to plan very carefully how to switch from the old to the new system."

While adjusting employee skill sets to operate and manage M2M has certainly been challenging, this change is already resulting in significant efficiency savings in human resources. Greater centralization of operations and the replacement of human operators by machines have all helped to reduce the wage bill **freeing up funds to be allocated elsewhere.** Maintenance procedures are another major target for cost-cutting through M2M, as Richard explains.

"One example of where M2M is helping to improve operations is in point maintenance. If a point starts to become worn or faulty we can see that happening and can schedule maintenance to address the fault before it becomes a problem."

"It is similar in rolling stock maintenance. Railway operators are able to **monitor their rolling stock more accurately,** they can see where they are being used and can again schedule maintenance to address any potential problem. It can be done in a very specific way due to the nature of the system." With the high level of safety that has to be maintained when developing new technologies for the railway, and also the

great volumes of data accumulated during the process, Richard says that applying M2M is a very technically challenging process.

Perhaps the most complex aspect is the huge volumes of data retrieved from M2M solutions which can take a great deal of time to process. Richard says in many cases it is not yet worth making the switch to these more advanced technologies due to the difficulties encountered and time it takes to apply the solution which can actually lead to a cost increase rather than saving.

Simplifying this process means streamlining a localized network **accessed remotely into a centralized platform which is** able to support multiple applications on different platforms. This is one aspect of M2M application that SBB's is currently working to address, and when it is achieved, it will have a major impact on the railways' system management efficiency.

SBB's Technology and Innovation department is currently studying how to migrate traffic management, command, control and signaling systems as well as operating management systems and their respective architecture into an **advanced rail management system**. It is hoped that such a system will be able to provide even greater efficiency of operations.

"There are different types of technology that we have to rely such as point-to-point and IP-Ethernet," Richard says. "Although right now it is very specific, there should be an effort to move towards a more harmonious system that is centralized. One possibility is to have Ethernet and another point-to-point or IP-based transport system to transfer information in parallel from one subsystem to another subsystem with each subsystem knowing what it wants to do. By using similar architecture throughout the system rather than individual separately operating parts, it will allow us to conduct **more efficient and better maintenance and operation of the network**."

One particular area that this could have a big impact is through ICT applications. While remote operation has streamlined and improved management, in the existing railway environment, even with M2M applications in place, the traffic manager is still the first person to recognize any traffic disturbance. As a result Richard says that SBB is currently considering how much efficiency can be gained by introducing a train traffic management system based on a holistic design for the so-called railway production management system.

The main difference that the new system will provide in architecture design is the use of cab signaling combined with an adaptive traffic management system. Under this approach, railway production management is separated from railway system management so that roles, competences and responsibilities are clearly defined.

It also implies a change in thought process within the railway **from asset-oriented thinking to service-oriented behavior**. At present railway systems generally employ reactive working practices with sub-system faults only identifiable after a failure is reported. But through monitoring and surveillance applications that work in accordance with sub-systems that monitor all relevant train, failures can be accurately predicted and disruptions potentially minimized.

Richard says that this new approach could have significant impact on rail operators and the supply industry. And while he admits it is still few years away from being reality, he advises that all sectors should be ready for change.

"We are in the very early stages of the conceptual stage, but once it is completed it will make the system much more efficient in all aspects," Richard says. "As the technology becomes more mature it will result in greater efficiency in operation at the subsystem which we believe will result in further reductions in operational costs."

THE RISE OF THE MACHINES

BY: THIERRY SENS, MARKETING DIRECTOR, ALCATEL-LUCENT, STRATEGIC INDUSTRIES SOLUTIONS

HIGHLIGHTS

- **Machine to Machine (M2M) technologies have been used by railways for many years in technologies such as train control, automation and signaling**
- **M2M has the potential to further optimize operations to achieve even greater efficiency and interoperability**
- **The combination of M2M and critical railway applications requires a robust and secure network and with IP/MPLS technology the rail operator gets the best of both worlds.**

There is lot of hype, buzz, and maybe even fantasy around the subject of Machine-to-Machine (M2M) technology. Some consider the term M2M as the precursor to a world where internet-connected machines are able to take the control of our lives, and even worse, our thoughts. Others see M2M technologies as a fantastic opportunity to improve life in all domains – from transport, to health and entertainment.

BUT WHAT ADVANTAGES CAN THE RAILWAY INDUSTRY GAIN FROM M2M?

Explaining what M2M can provide must begin by defining it. This is not an easy task as there are so many definitions available. However, the one which seems the most precise is: "An unlimited, ubiquitous and connected universe in which machines and back-end applications communicate to monitor, control and collaborate."

In this respect, the railway industry is a pioneer in this area of M2M. Train control, automation and signaling are all technologies that talk to back-end systems and were deployed by the transport industry long before M2M became a hot topic. Yet M2M technologies are now opening up new considerations that the transport industry should be willing to embrace in order to reap further benefits, such as increased openness and standardization, scalability and security.

As Jan Richard, Swiss Federal Railways' (SBB) director Innovation and Technology manager, tells us, SBB is currently looking to move away from remote M2M applications by centralizing its management system which will be able to **handle all types of architecture and create further efficiency savings.** M2M is therefore providing huge opportunities for railways such as SBB to get rid of proprietary systems and protocols by allowing different systems from multiple suppliers to **interoperate together**, and to introduce **new services for improving operations**. It could also facilitate better **links with other transport service providers** to create a truly seamless travel experience.

ORCHESTRATING INTERACTIONS, PRIORITIZATION AND STANDARDIZATION

M2M is hugely reliant on the internet, and its open standards such as IP (Internet Protocol), XML (eXtended Markup Language) and Web Services. As Yiru Zhong, a senior industry analyst at Frost & Sullivan, points out the use of these applications not only eases the interoperability of heterogeneous systems, it also facilitates integration with existing technologies and applications. This can consequently lead to reductions in the human cost of operation and the risk of human error so often the cause of problems on the railway, and also, perhaps most importantly, **reduce the amount of time rolling stock is out of service.**

When deploying an M2M solution, we don't just install wireless sensors and equipment inside a rolling stock asset or within infrastructure; we also insert an M2M framework in the back-end. The aim of this framework is to orchestrate and prioritize the data exchanged with front-end devices, and to link with the different applications plugged into the framework. This highlights the value of an M2M solution compared with traditional solutions because instead of having individual sensors, or an on-board system, talking to their respective back-end applications in a fragmented way, **the single middleware syndicates and manages all flows.**

One must also consider the value of a piece of information for various systems, because in the case of the railways the same piece of information can be used for many things by many different parties as long as the platform is well conceived.

This concept facilitates the deployment of new application and services, while reducing upgrade and maintenance costs. A single M2M platform can therefore easily manage different applications and services such as **geo-localization of rolling stock, real-time alarms, geo-fencing alerts, fleet and asset management, corrective and proactive maintenance procedures, and train control.** An M2M solution cannot though be deployed without a mission

critical IP network supporting it. This is the main difference between a M2M solution for railways and an Internet of Thing (IoT) solution for consumer needs.

GUARANTEEING SECURITY AND RELIABILITY

As Jarrett Walker, a principal consultant with McCormick Rankin and Cagney, and a prolific blogger, highlights, the public remains sceptical about the safety of railway operations that are not operated by humans. Efforts undertaken by the BART system in San Francisco and on Vancouver's automated metro lines to alleviate passenger concerns about automated operation are proving to be effective consequently allowing M2M technologies to provide the highly-efficient and frequent services demanded on modern urban transit networks. It is absolutely essential though that we continue to guarantee the security and the reliability of critical railway applications and information in the next generation of applications.

Traditional IP and Ethernet networks lack the ability to optimize the use of network resources. By adding MPLS, the rail operator gets the best of both worlds – an IP network that has the robustness and predictability of a circuit-based network, and a highly scalable and reliable system that addresses a range of QoS (Quality of Service) requirements as well as optimizing bandwidth usage through traffic engineering.

M2M technologies and IP/MPLS networks offer new possibilities for railways operators to rethink the way train control, signaling and automation applications are implemented today

An M2M solution hosted on the same framework as various non-critical business and mission-critical operational applications can be deployed on a single unified IP/MPLS network. And despite its mutualization, the network can also provide a dedicated SLA (Service Level Agreement) and QoS per type of application, making the whole M2M solution reliable, flexible and cost effective.

M2M solutions will become even more effective when the railway industry invests in LTE (Long Term Evolution), the new broadband wireless technology also known as the **4th generation (4G) network.** Under this system the information is transmitted wirelessly, but no less securely, over a wide area. This potentially will lead to every single piece of equipment to be fitted with a radio module that will enable at worst a reporting of its own status, and at best a full two-way interaction. LTE is tailored to support any mix of critical and non-critical applications and is IP native, enabling it to be fully embedded with an IP/MPLS network.

M2M technologies and IP/MPLS networks offer new possibilities for railways operators to rethink the way train control, signaling and automation applications are implemented today. And as the other articles in this newsletter have shown, they also open up opportunities for railways to implement new operational applications, lower operational costs and increase interoperability.

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CONTACT: olivier.andre@alcatel-lucent.com

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