LTE - service opportunities, threats and challenges for the rail industry

Iain Sharp – Director, Netovate
info@netovate.com

@netovate

netovate

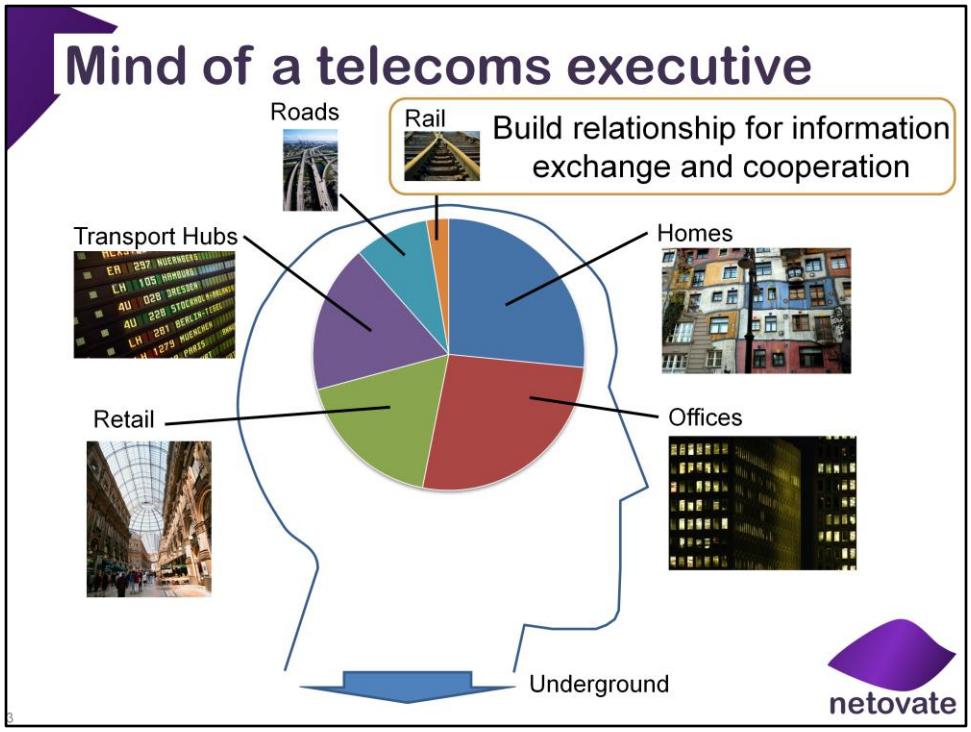
Please view notes for further information on later slides

Introduction

20 years experience:
GSM, GPRS, UMTS, LTE, IMS

Key LTE characteristics and how they change the telecoms environment

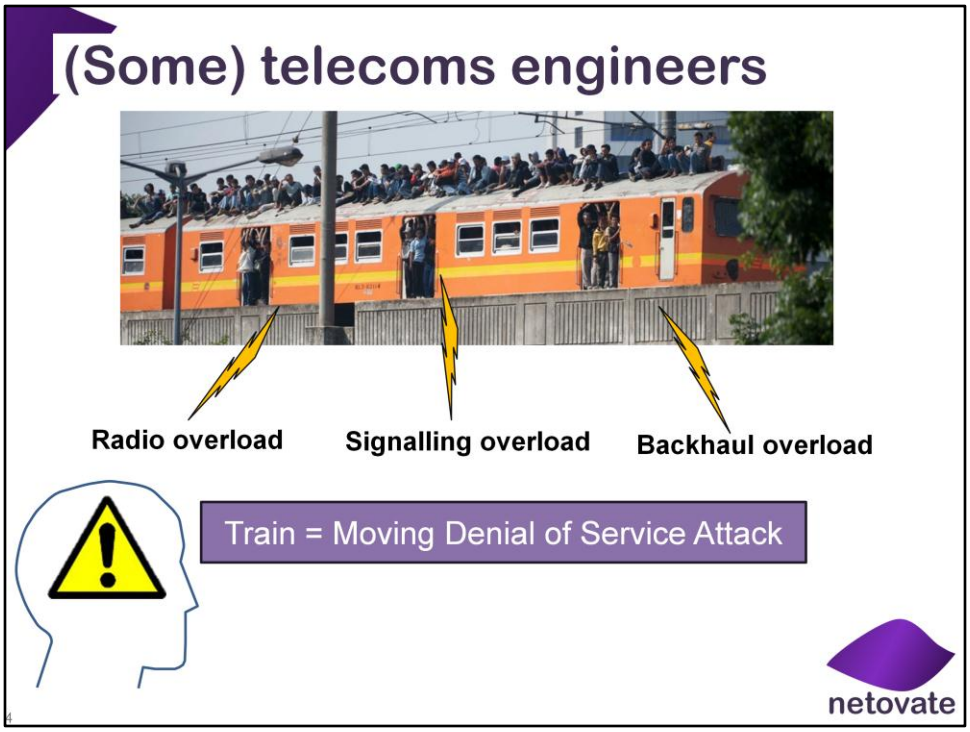
Consequences for rail



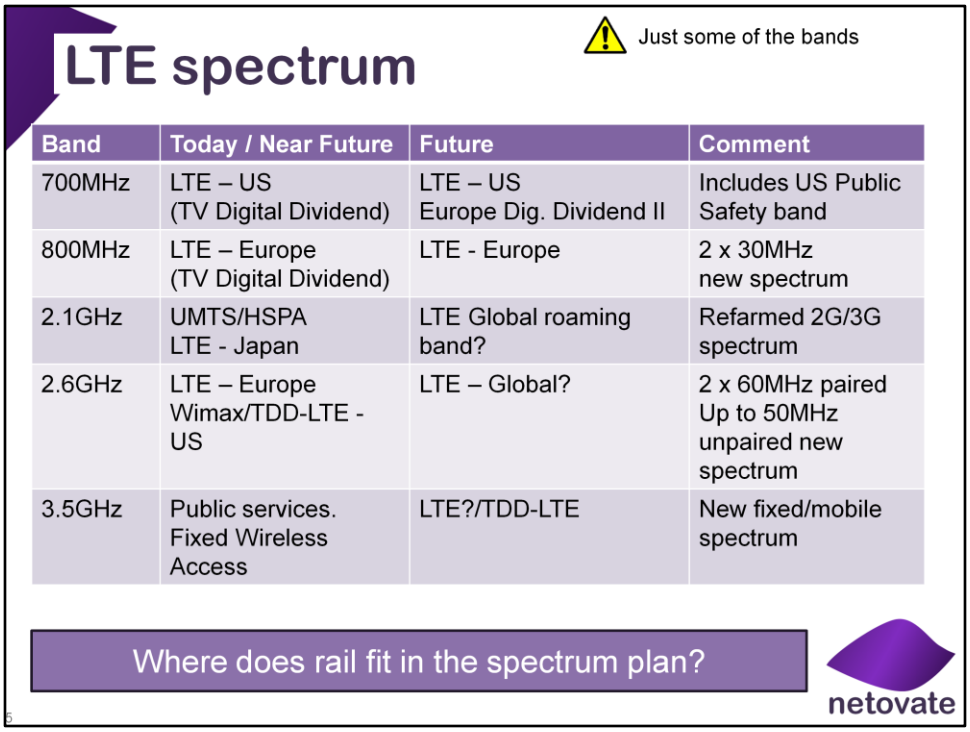
Mobile telecoms planning is driven primarily by coverage of population and secondarily by coverage of geographic area, often with reference to licence conditions. Railway hubs may be prioritised in this model but rail tracks themselves are not generally seen as a centre of population and may not be recognised as requiring any special coverage. Still we see that attitudes are changing in the mobile operators and that the move to tiered pricing encourages deeper consideration of how to bring data traffic on to the mobile network. Features like Mobile LTE Relay (see later) show that mobile industry is starting to think explicitly about rail applications but perhaps not learning fully from past experience.

Different investment cycles in telecoms and rail industries make it hard to coordinate a business approach.

Success for both sectors will require building a relationship for cooperation and information exchange. Aim for telecoms industry to recognise opportunity in rail sector but also requirements to address that opportunity. The rail industry to understand the business imperatives in the telecoms sector and how best to make use of available telecoms technology.



The technical difficulties of providing high-capacity services to trains should not be underestimated. Even with the extra capacity of LTE the passage of a crowded train has the potential to cripple the local network and degrade service to other users. LTE on its own will not meet all the challenges of the rail environment.

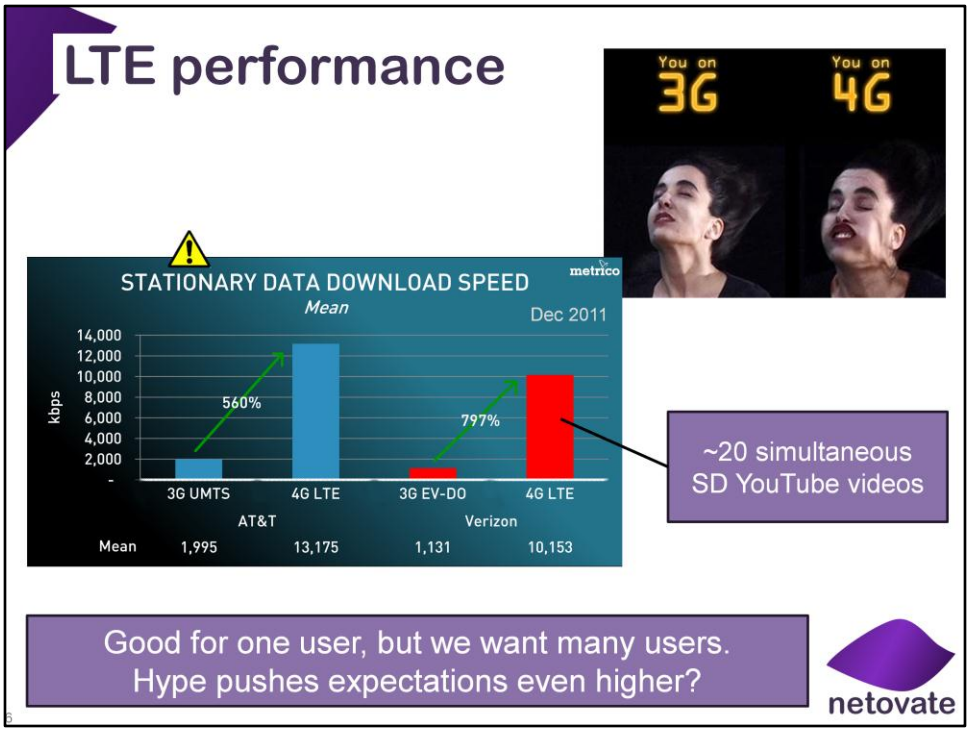


One of the main reasons to be excited about LTE is the associated allocation of new spectrum. The global picture for LTE spectrum is very complicated and fragmented but broadly there are two spectrum ranges being allocated in most countries:

1) The smaller region at around 700/800MHz in digital dividend which is good for meeting moderate capacity requirements over wide areas
2) A larger region at around 2GHz which can provide more bandwidth but with more limited coverage.

Where does rail fit in this spectrum plan? Most countries are not reserving LTE spectrum for particular industries or user groups therefore rail will either need to buy its own spectrum access or buy services or spectrum rights from other spectrum owners like mobile operators. One interesting question is whether rail could be a suitable application for “TV white-space”?

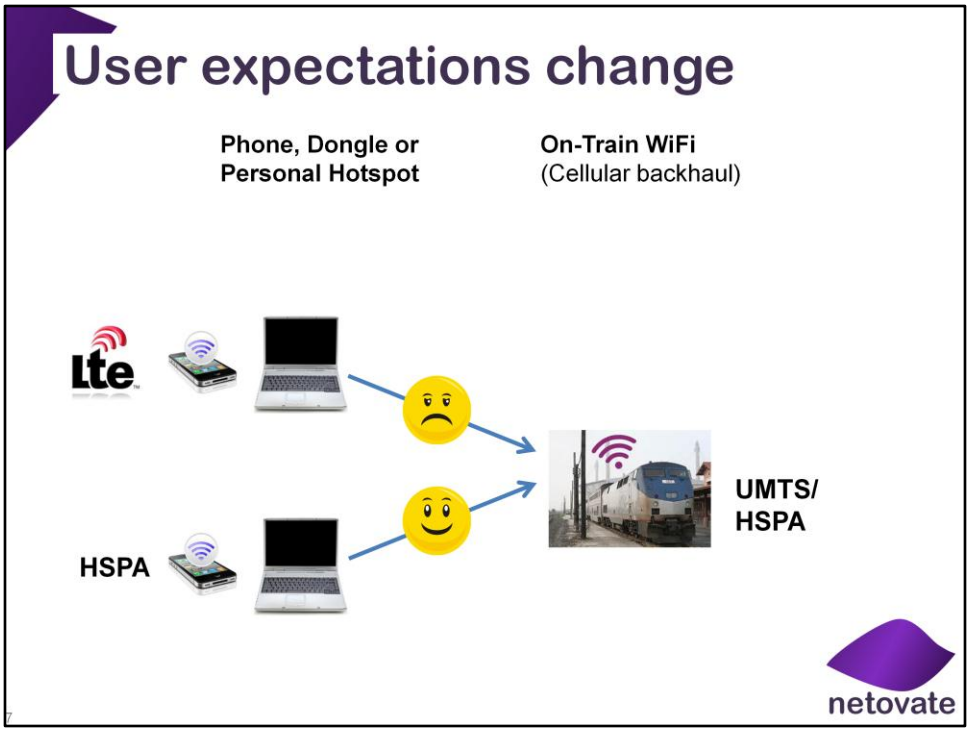
Notable exception to the general trend of not reserving spectrum for particular users is in the US where some 700MHz spectrum has been reserved for LTE-based Public Safety systems. This is potentially interesting for rail as it provides motivation to build service capabilities on the LTE platform which might also be relevant to rail.



Bringing LTE or “4G” to market has been accompanied a lot of hype both to consumers and within the industry about the data rates which will be achieved. It is important to try and look behind the hype to understand the reality.

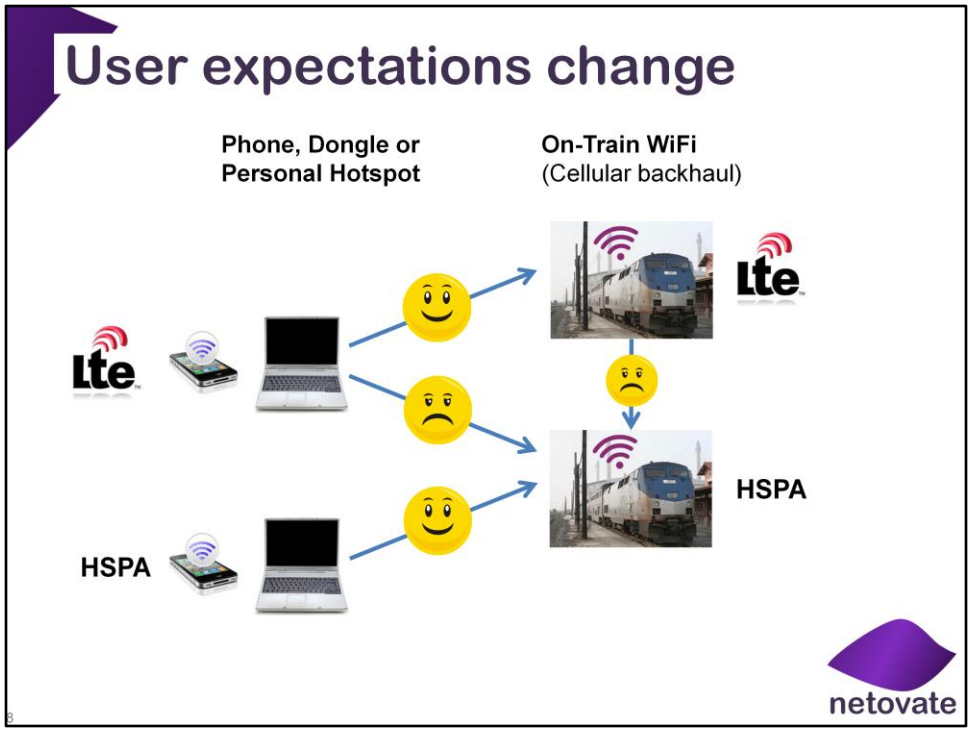
Early indications are that LTE is indeed a vast improvement over existing technologies both in terms of raw bandwidth and other desirable features like latency. Surveys suggest average data rates of between 10 and 13Mbit/s to stationary handheld devices on the US LTE networks. Early reports of LTE coverage to trains suggest 20Mbit/s averages can be achieved. The effective upper-speed bound of LTE in real world scenarios is something that still needs to be explored. Of course we don’t yet know how this performance will change as the networks become more heavily used and congested.

Though the data rates are impressive for a single users a lot of rail applications consolidate multiple users on to a cellular backhaul connection. In this context the speeds may still be seen as somewhat limited. 10Mbit/s is only around 20 simultaneous standard definition YouTube streams so this is hardly sufficient to provide video entertainment to a whole train (and perhaps not even a whole carriage) of users. Meeting consumer demand for video is still going to be a challenge that will need particular attention.



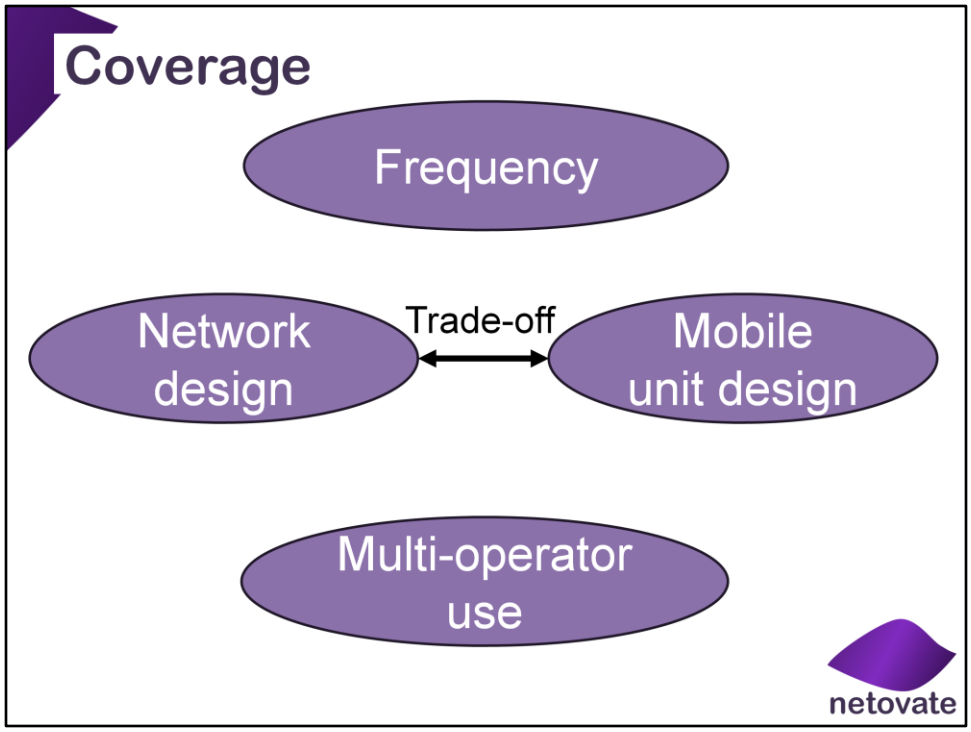
The significant improvement in data rates that users experience with LTE has the potential to raise expectations for performance of in-train WiFi to levels that cannot be achieved by existing solutions based on 3G backhaul. A users experience with a personal LTE dongle or hot-spot may well be better than they get with in-train WiFi. This may mean that instead of using WiFi the users will attempt to make use of their LTE connection and then experience difficulties due to the screening effect of the rail carriages.

Particularly if users are paying for WiFi or see it as an important reason for choosing rail travel they may be dissatisfied if WiFi does not keep pace with improvements in their cellular service.



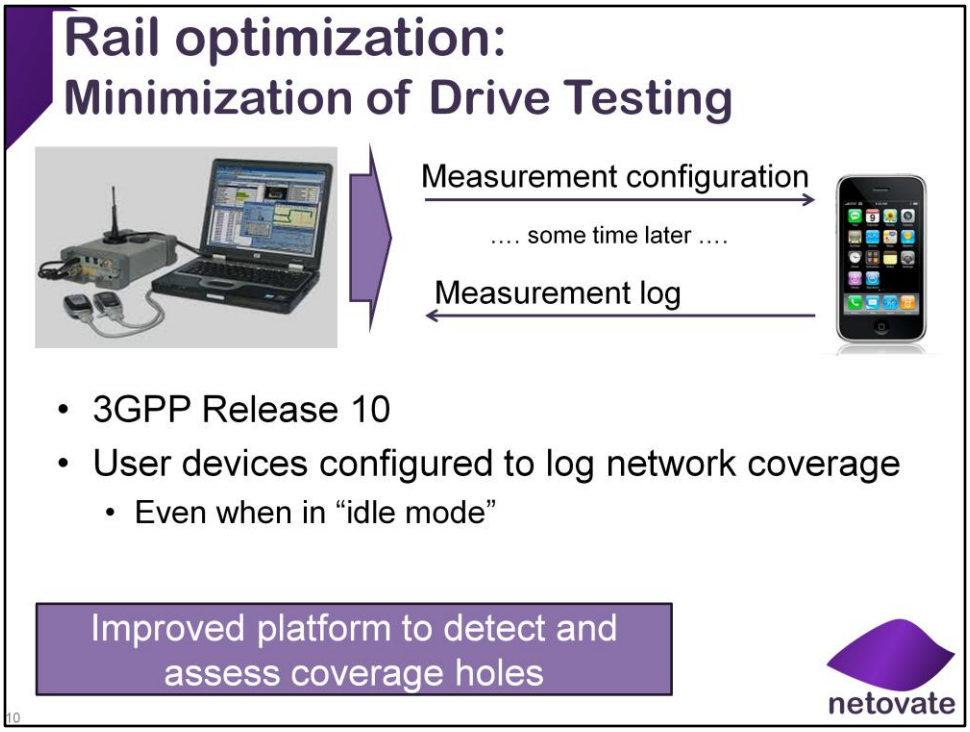
Train operators should react to increasing expectations by equipping trains with LTE backhaul for WiFi. Built-in LTE systems should perform significantly better than personal LTE devices due to the better antenna location and the ability to aggregate multiple connections (potentially even from several operators).

The problem then is how to deal with consistency as the train moves between areas of 3G and LTE coverage – may users in fact find a highly variable service more annoying than a slower but more consistent service?

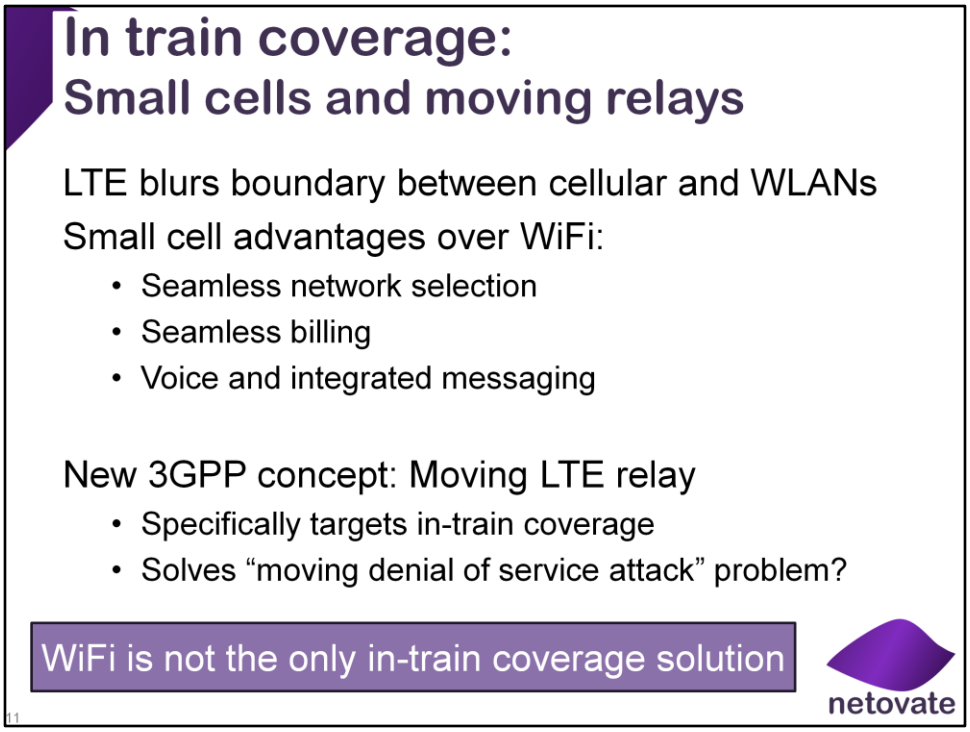


Four main factors influence coverage.

1) Frequency discussed under spectrum
2) Network design is a topic in its own right and not expanded in this presentation
3) Multi-operator use is going to be more complicated as networks increasingly share resources.
4) Mobile unit design – performance of the mobile unit is often overlooked as a determining factor in system coverage and performance. Trade-offs can be made between improvements to networks and improvements to mobile units in order to achieve the same coverage/performance



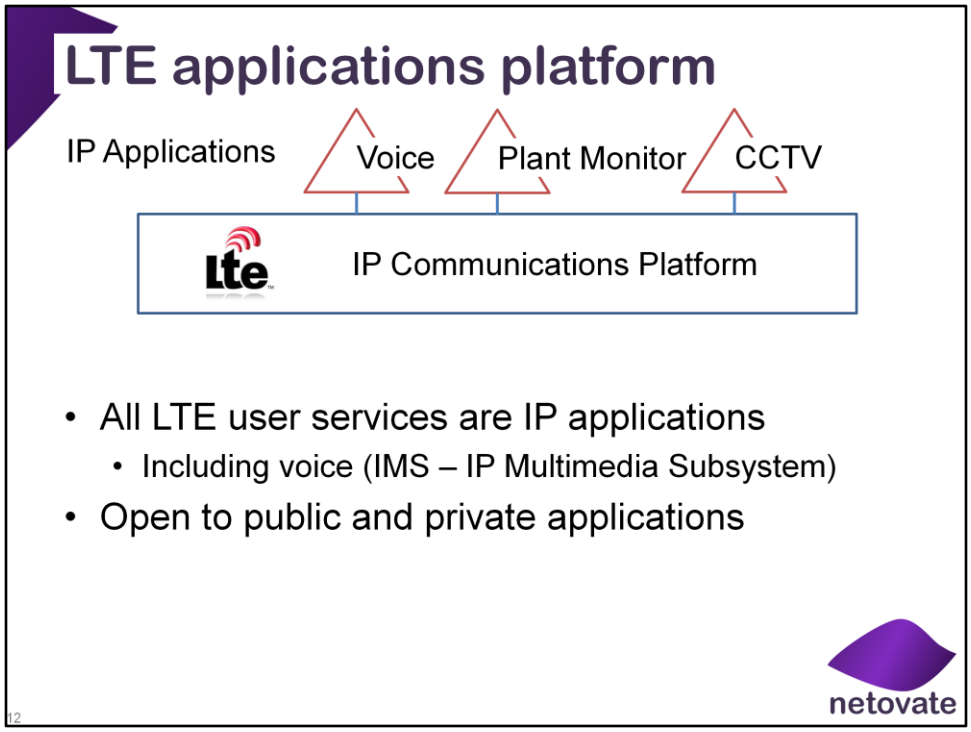
New coverage measurement tools can help in understanding existing coverage and planning improvements. Conventional “drive testing” is a laborious process particularly (as the name suggests) for off-road locations. Minimization of Drive Testing allows any supporting mobile unit to log and report coverage measurements under network control (even if it is not actually engaged in an active session). Enabling MDT on train mounted mobile units could be an important tool to improve rail coverage. MDT will reduce the cost of making coverage measurements and vastly increase the amount of coverage data which can be captured.



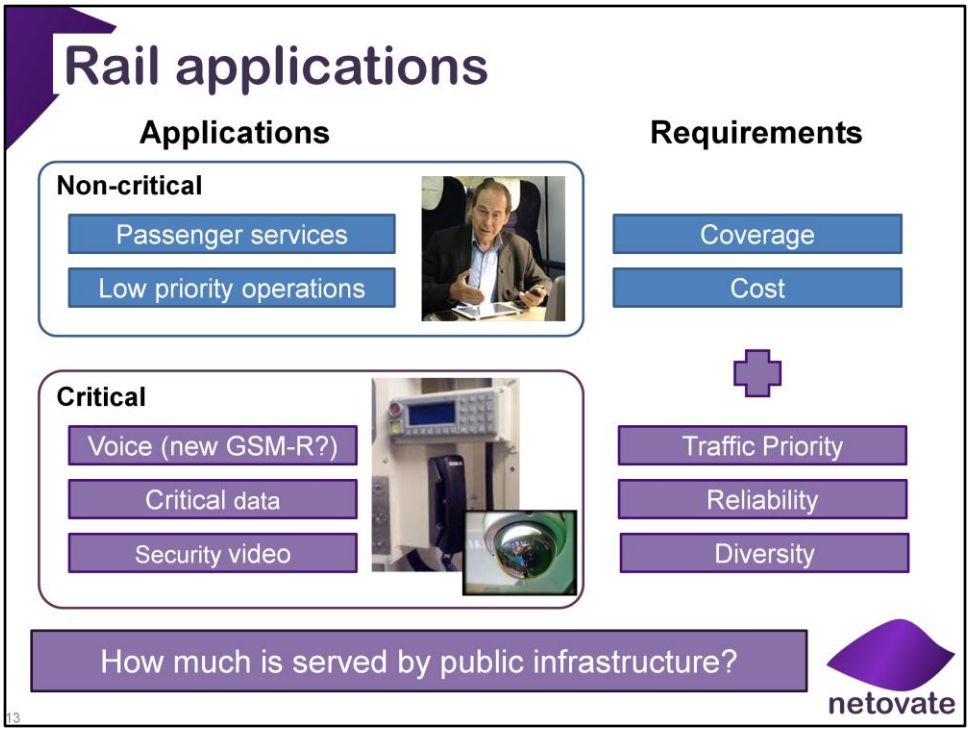
We are used to thinking of WiFi as the primary technology to provide wireless coverage inside a train. LTE blurs the boundary between WiFi and cellular and mobile operators are strongly pushing "small cell" solutions for coverage and capacity that they claim provide a more seamless user experience than WiFi.

Against this background it is not surprising that the mobile industry thinks in terms of relaying the LTE signal as the preferred mechanism for providing data services to train users. A new work item under the title of "Moving LTE Relay" has recently started in 3GPP, the standards body that defines LTE. This specifically addresses in-train coverage including support for high-speed group mobility. Combined with mobile operators' ability to charge for data services this could be an interesting departure from existing in-train systems where billing is difficult. The Moving LTE Relay work item currently lacks input from the rail community and therefore there is a significant risk that the requirements being developed will not fulfil the needs of the rail industry.

Even though the 3GPP work may not be on the right track it is still important to consider non-WiFi in-train coverage solutions.



The use of a pure IP applications platform in LTE is a significant break from 2G and 3G technology which had special operating modes for voice and SMS. This platform is very open to the introduction of new user services for both public and private applications.

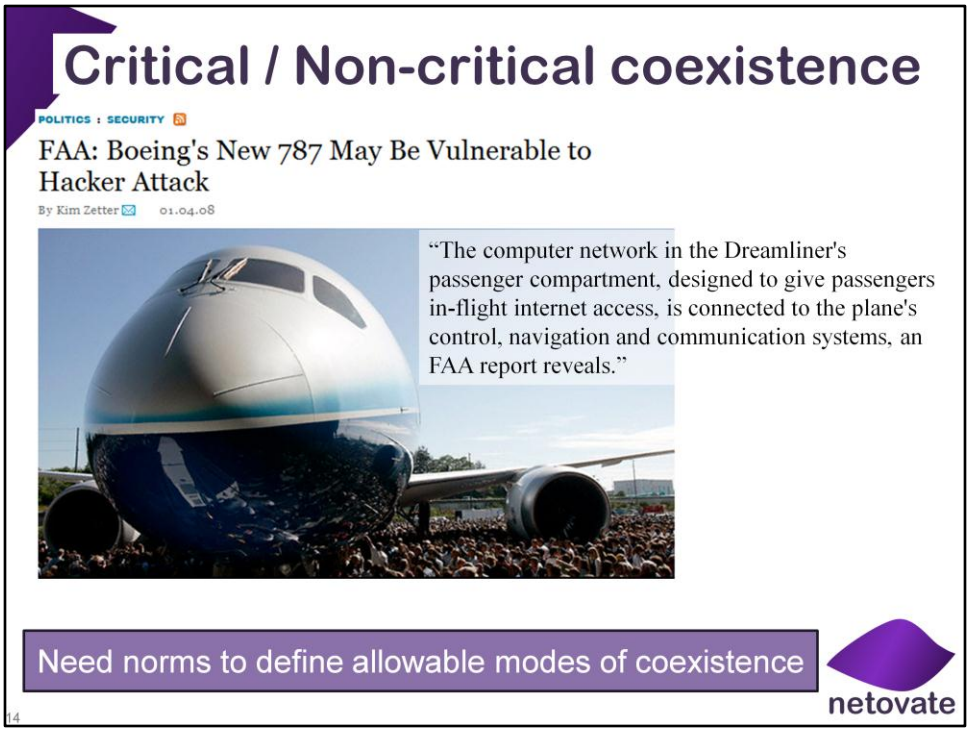


We have shown how LTE provides a good technical platform for non-critical services – the main constraints are coverage and cost. LTE can deliver large volumes of data. Can you afford to pay for it?

Why should we consider LTE for critical services?

- Existing systems are not always suitable to meet new requirements – eg data intensive applications such as uplink security video.
- Existing solutions will reach end-of-life and need replacement.
- As there is increasing demand for spectrum it will become more difficult to gain exclusive access to spectrum. Solutions that allow critical rail services to coexist with other spectrum users can prove to be cost effective.

For critical services many new requirements are added in to the mix including priority and reliability. To some extent LTE provides a framework to address there requirements but the LTE capabilities have not been analysed in the context of the full rail requirements. The critical question here is to define what set of services we see as being supported by LTE and then form an action plan to address the requirements.



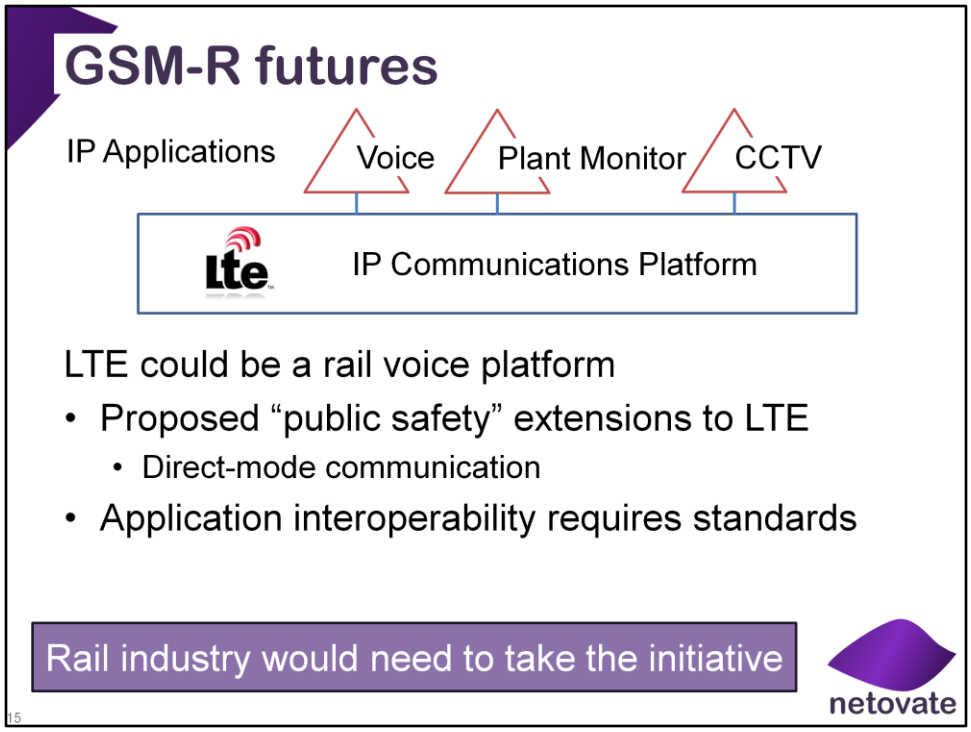
We can learn from the experience in other industries on the coexistence of critical and non-critical apps.

In the design of the 787 Boeing decided to use some common components between the passenger LAN and the flight-control systems. This lead to a special FAA approval process and some initially hysterical headlines. Ultimately though the design was considered secure and approved.

We can take away two things from this experience:

- Other industries are accepting that "Air gaps" are not the only approach to separating critical and non-critical systems
- If we are going to allow coexistence we need to define industry norms for what modes of coexistence are allowable and which must be avoided.

Additional notes:
Source for quotes:
Wired Magazine:
http://www.wired.com/politics/security/news/2008/01/dreamliner_security



One particularly interesting piece of work is the development driven by the US of a "public safety" application based on the LTE platform. Public safety has a number of similar features to rail communications including group calling, addressing by function rather than individual and strict priority and preemption protocols. The US is also proposing to enhance the LTE platform to include a "direct mode" of communication which does not go via the LTE network. This project is still very new and the success is far from certain but I think it is reasonable to hope that the public safety work could point the way for a future application of LTE for GSM-R communications.

Though IP applications can be easily built on top of LTE interoperability of these applications requires additional standards. It would be better to deliver interoperable GSM-R communication than have may different implementations.

Conclusion

- LTE is a major mobile advance
  - Spectrum, data performance and open IP service platform
- Service applications
  - Passenger service backhaul (of course)
  - Non-critical operations
  - Critical operations
- Rail industry needs to define scope of application of LTE
  - Access to spectrum
  - Clearly understand technical requirements
  - Business model that engages public networks
- Open a dialog with the mobile sector

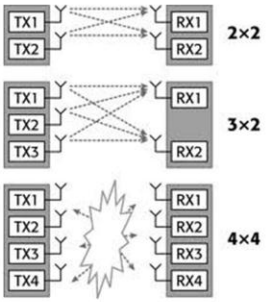
About Netovate

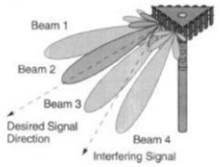
- Independent consultancy and analyst built on 20 years experience in mobile
- Services available:
  - Technology evaluation and assessment of business implications
  - Intellectual property assessment and assertion
  - Technical standards analysis and representation
  - Service and solution design and assessment
  - Feasibility analysis of new proposals

Backup

Mobile unit design:
Trains don't fit in your pocket…

- Very high order MIMO …8…16
- Beam forming
- High sensitivity receivers
- Higher power transmitters
  - Safety / regulation



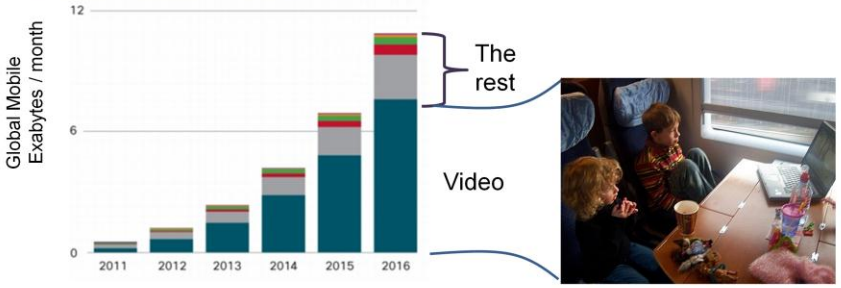


Understand cost / benefits for better radios

netovate

19

Downlink video



LTE enables more video on more devices in more places

Three pillars to video strategy:

- **Network stored content**
- **Train stored/cached content**
- **Live TV**

User experience: consistency?

netovate

20

Uplink video / CCTV

Bandwidth for real-time uplink video

Subject to:

- Cost
- Coverage
- Network resilience (disasters)

“Push” and “Pull” recovery

Design system diversity to protect against single points of failure

netovate

21

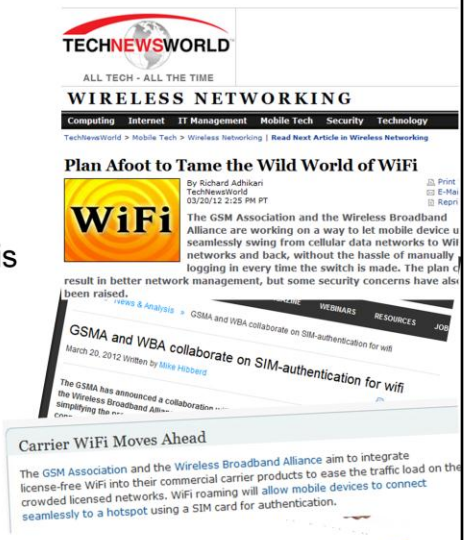
In train coverage: WiFi

WiFi is becoming part of carrier's service pack

"Silent" selection of partner WiFis

SIM authentication

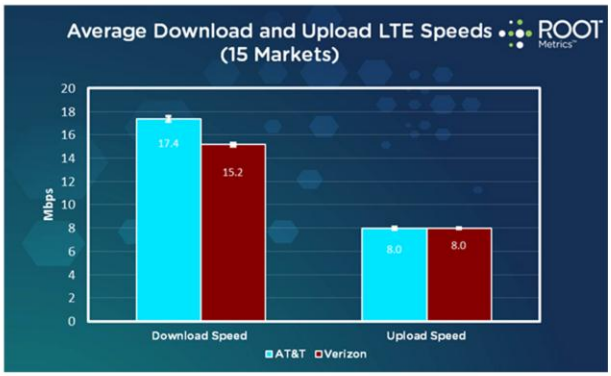
Integrated billing



Need integration strategy for on-train WiFi

netovate

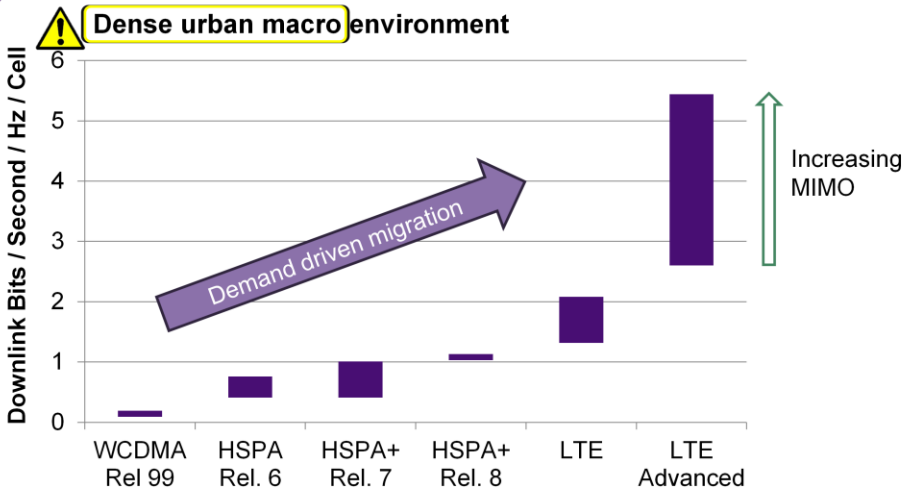
LTE achieved data rate 2



April 2012. Source: http://gigaom.com/2012/04/14/solving-the-lte-puzzle-comparing-lte-performance/

netovate

LTE cell spectral efficiency



Source: Real Wireless/Ofcom

netovate

24