Joint Event between the Digital Communications Knowledge Transfer Network and Cambridge Wireless Future Wide Area Wireless SIG

25th March 2010

'Standards and the New Economy'

Technology Background

It is hard enough keeping up with the evolution of standards in the cellular industry but increasingly we need to validate standards work across all physical layer media including cable, copper and fibre. The following brief overview of physical layer standardisation is intended to provide some useful background to this work.

Fibre

Fibre began as multi mode and then single mode operation was demonstrated; similarly a single wavelength progressed to multiple wavelengths, multiple generations of optical technology evolution.

Single mode fibre is used for backhaul and can support data rates of 40 Gbit/s or above. It has a loss of about .37 dB per km at 1310 nanometers. It is expensive when compared with multi mode fibre and requires expensive connectors and exotic laser diodes.

Time division multiplexing has been traditionally used to give multiple channels. Multi mode fibre is relatively low cost when compared to single mode fibre and does not require expensive high precision connectors. However it has a relatively high propagation loss, about .8dB per km at 1310 nanometers and relatively low bandwidth when compared with single mode.

Newer multi mode fibre also supports longer wavelength transmission at 1510 nanometers. Attenuation losses reduce to about .23 dB per km but chromatic dispersion is worse.

Fibre is used extensively in passive optical networks. The ITU-T G983 specification defines the downstream at 1490 nm at 622 M/bits/s, a 155 M/bits upstream at 1310 nanometers and an RF video overlay at 1550 nanometers.

As with wireless access, standards have to be agreed. For example, present discussion is ongoing as to whether 100 Gbit/s wavelength division multiplexed fibre should use dual polarized DQPSK or OFDM.

The 18 billion dollar FioS Optical network being deployed by Verizon in the US is an example of a passive optical network based on a combination of multi mode and single mode fibre transport.

Even allowing for multiplexing on the multi mode drop, these networks offer super-fast downloads of recorded content including high definition video, multiple (200 or more) standard TV channels and high definition TV. Peak rates are capped per user at 45 M/bit/s but could theoretically be much higher.

Cable

Cable data rates are lower than fibre but in common with fibre are increasing over time. The increase in data rate has primarily been delivered through the adoption of higher order modulation schemes.

The downstream frequencies used in cable are typically from 42 to 850 MHz with an upstream between 5 and 42 MHz in the US and between 5 and 65 MHz in Europe.

The table below shows how data rates have increased over the past ten years over three generations of DOCSIS (data over cable service interface specification).

Table 1 Three generations of DOCSIS cable specification

DOCSIS	DOWNSTREAM	UPSTREAM
DOCSIS 1.0	38 M/bit/s	9 M/bit/s
DOCSIS 2	38 M/bit/s	27 M/bit/s
EURODOCSIS 2/DVB C	51 M/bits	9 M/bit/s
DOCSIS 3.0	160 M/bit/s	120 M/bit/s

DOCSIS 3.0/Eurodocsis will be needed to support a credible offering of high definition TV and is designed to be IPV6 compatible. The higher data rates are achieved partly by higher order modulation schemes and partly by channel bonding.

Eurodocsis is essentially a redistribution of the uplink/downlink budget to support the 8 MHz digital TV channel bandwidths and data rates needed to meet European DVB-C broadcast requirements.

Table 2 shows DVB-C modulation options and data rates. Present standardization efforts are being directed towards producing a new iteration of DVB-C known as DVB-C2.

Table 2 Example Modulation options and data rates for an 8 MHz digital TV channel

Modulation	16QAM	32 QAM	64 QAM	128 QAM	256 QAM
Data rate Mbit/s	25.64	32.05	38.47	44.88	51.29

Copper

The copper alternatives are shown in Table 3. In common with cable modems, ADSL modems use higher order modulation schemes, typically 16 level QAM. ADSL2+ sacrifices uplink bandwidth to deliver a 24 M/bit downstream which can be increased theoretically to 48 M/bit/s using channel bonding.

Table 3 ADSL and VDSL Modem options and data rates

ADSL	Downstream	Upstream	VDSL2		
ADSL2	12 M/bit/s	3.5 M/bit/s	Low profile	Medium Profile	High Profile
ADSL2 +	24/48 M/bit/s	1 M/bit/s	25 M/bit/s	30 M/bit/s	100 M/bit/s

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Standards and the New Economy - the second of a series of three meetings

This is the second of a series of three meetings being organised by the Cambridge Wireless Future Wide Area Wireless (Spectrum and Standards) special interest group.

This first meeting held on the 24th September 2009, **'Spectrum and the New Economy'** studied the role that radio spectrum and can play in national economic recovery, how techniques that deliver improved spectral economic efficiency could or should influence future spectral policy and/or deliver long term **market** advantage to the UK. Presentations from this event can be downloaded from the **RESOURCES** section of the Cambridge Wireless website.

This next meeting on the 25th March 2010, **'Standards and the New Economy'** analyses the impact that standards have on the economics **of wireless broadband and point to point, point to multipoint and multipoint to multipoint delivery (first mile/last mile/middle mile) when analysed side by side with the technology advances being made in other areas including fibre, cable and copper**. These technology advances suggest that bandwidth delivery cost may be falling faster in fibre, cable and copper than in wireless. If true, this has profound implications for the wireless delivery industry. One solution is to delivery more closely integrated standards across all delivery platforms, the other is to clearly understand where wireless **mobility** delivers unique value particularly in wide area and broadband global area networks.

The third meeting **'Networks and the New Economy'** on 9th November 2010 analyses the convergence that is taking place between wireless and wireline networks at technology level both at the edge and the core, the implications this has for network bandwidth delivery cost and efficiency, the impact this is having on industry business models and how network convergence can deliver long term **competitive** advantage to the UK.

We explore the **technology and engineering** notion of **'The Big Switch'**, tracing the transition from electro mechanical switching to centralized digital switching to the distributed routing increasingly being used in wireline and wireless networks and question some of the cost efficiency assumptions that are presently being made.

We explore the **market and business** notion of the **'The Big Switch'**, whether wireless and wireline networks can deliver additional user value from these new network topologies.

This includes an assessment of the contribution that telecommunications can make to realising a low energy economy **(economy networks and the network economy**) both in terms of the way that telecommunications networks are powered (including wind and solar power), how telecommunications use that power (energy efficient base stations, switches, servers and routers) and the direct role that telecommunications can play in helping people and organisations to use less energy. (Smart Grid, Smart Home and Smart Business energy initiatives).

In parallel we explore the potential convergence of telecommunication networks and environmental networks including the role of distributed sensing and control (**Environmental networks and the new economy).**

This event may be held at the Science Museum if the Strowger exchange has been put back into working order.

If you are interested in sponsoring or speaking at the third event then please contact **clare.kettle@cambridgewireless.co.uk**