



# Small Cells: Evolving Network Architecture 2012

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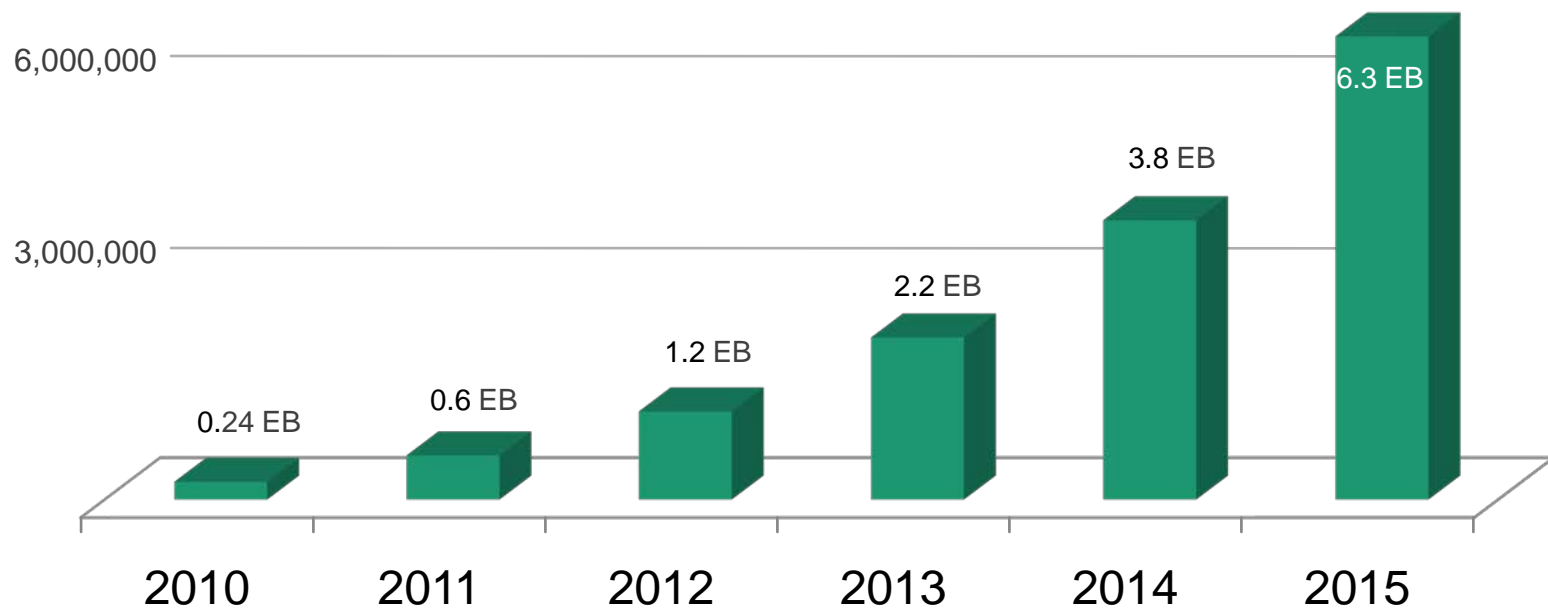
# Introduction

- Dramatic increases in mobile data traffic are driving the evolution of wireless communications networks.
- Additional spectrum and advances in wireless standards (higher bits/Hz) are necessary and being implemented but are insufficient.
- Large deployments of base stations will also be required to meet capacity requirements over the next 8-10 years.
- Wireless network traffic distributions and constraints on site acquisition make the deployment of macro cells ineffective for the next generation of wireless networks.
- Instead, the majority of network growth will come from the deployment of massive numbers of small, low power cells (pico cells).
- These new architectures will solve capacity problems but bring their own set of challenges.

# Updated Cisco VNI Mobile Data 5-Year Rolling Forecast Predicts 26X Traffic Increase

*Terabytes per Month*

92% CAGR 2010-2015



Cisco Forecast's 6.3 Exabytes per Month of Mobile Data Traffic by 2015

*Mobile-Connected Tablets will generate as much traffic in 2015 as the entire Global Mobile Network in 2010*

Source: Cisco VNI Mobile, 2011  
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Proprietary Information

# 2011 Cisco VNI Report: Trends

- In 2010 mobile data traffic nearly tripled for the third year in a row. Last year's CVNI report underestimated the growth, at 149% versus revised 159%.
- Very interesting to see the massive increase in traffic from 2014 to 2015 of 2.5EB (6.3EB in 2015). The forecast traffic trend definitely continues from last year's forecast of 3.5EB in 2014, which this year is revised upward to 3.8EB.
- Europe data points:
  - SFR's mobile data rate has tripled each year since 2008.
  - TIM (Italy) delivered 15X more mobile data in 2010 than in 2007.
  - TeliaSonera expects mobile data traffic to double each year for the next 5 years.
- The "Rolling 5-Year" Cisco Mobile Data Traffic Report, now 2010-2015, predicts an increase of 26X.

# 2011 Cisco VNI Report: Device Highlights

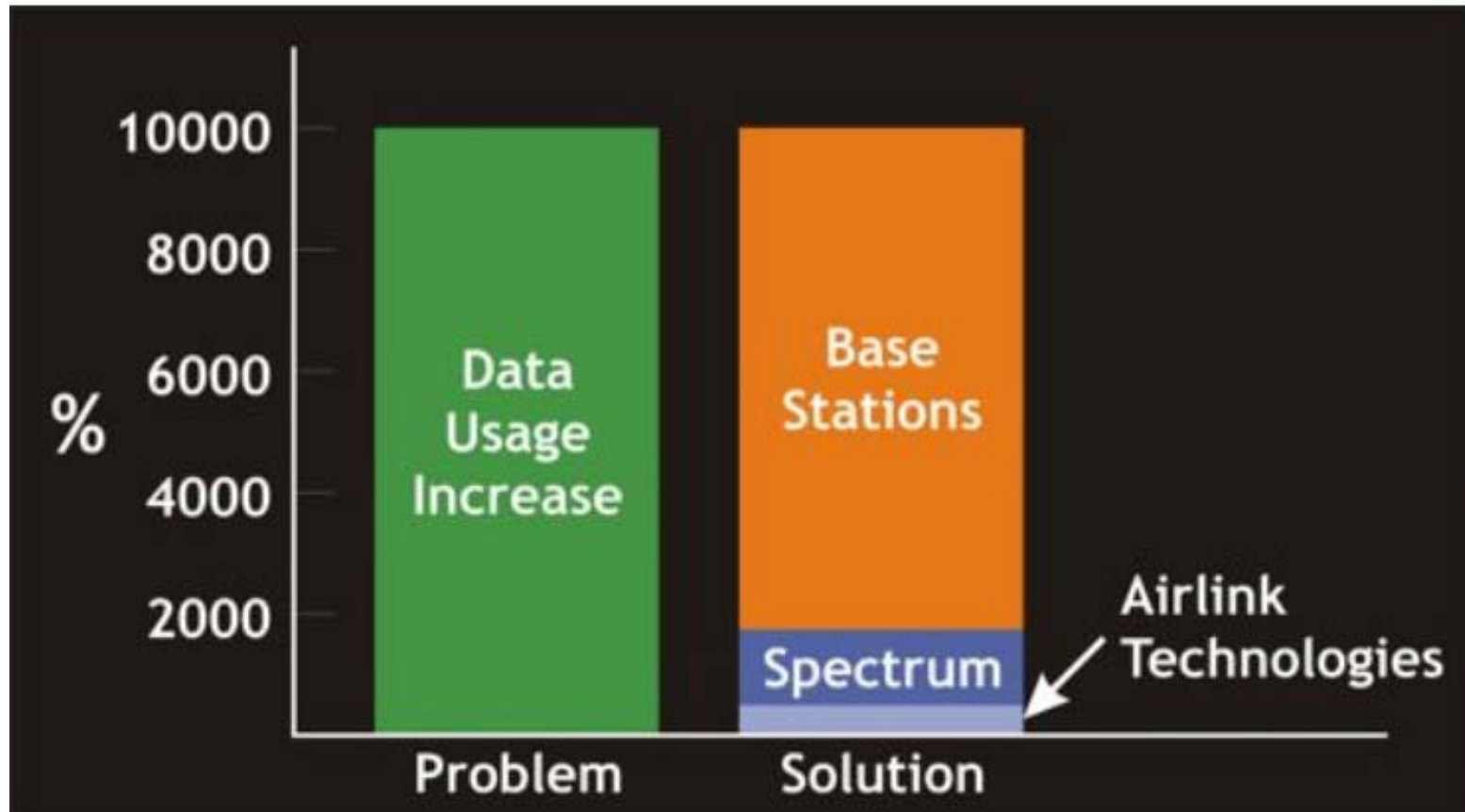
- Smartphones now at 13% penetration but generate 78% of global handset traffic.
- 3M tablets connected in 2010 each generating 5 times as much traffic as the average smartphone. In last year's Morgan Stanley Internet Trends (June 2010), MS estimated iPad usage at only 2X the iPhone, whose usage has already been almost matched by the Android Platform, according to CVNI. MS reported Android at 0.5X the iPhone usage last year.
- Laptops attached to the mobile network approaching 100M and generating 22 times the average smartphone.
- The average speed for a smartphone in 2010 passed 1Mb/s. By 2015, the all-device connection speed average will increase 10X to 2.2Mb/s.
- Finally, mobile connected tablets will generate as much traffic in 2015 as the entire global mobile network in 2010. We assume this may be more pronounced in rich, western countries. The real numbers may still be under estimated.

# Historical Increases in Network Capacity

- The exponential increase in traffic will define how operators evolve their businesses and drive network evolution for the better part of this decade. Where does capacity come from?
  - **Additional Spectrum:** Mobile frequency has grown over the last 25 years in the US on a compound annual basis (CAGR) of 8.31% This is marginally higher in the European Union.
  - **Additional Sites:** CTIA reports cell sites have grown from 82,000 in 1999 to 247,000 in 2009, or an increase of 7.05% CAGR.
  - **Technology:** Over the last five years (HSPA rls 6 to LTE w/ 2X2 MIMO) the gain in spectral efficiency is 11.7% CAGR.
  - Total: Given all of these increases, operators can expect their network capacity to increase, on average, at 29% per year.
- 2011 Cisco VNI Report predicts that demand increases by 92% CAGR 2010-2015.

# Carriers will need to Deploy 10X Base Stations

Source: *Maravedis, Infrastructure Trends, August 2010*



# LTE Rolling out in Western European Countries

- European Mobile Operators are deploying 4G networks and enhancing existing 3G as quickly as possible to prepare for traffic increases and expanding subscriber services.
- Germany is leading the charge. The 2.6GHz bands were auctioned in 2010. Also, 800 MHz spectrum was auctioned with the stipulation that carriers expand LTE coverage to rural areas. Vodafone and the other operators are deploying thousands of LTE eNodeB this year.
- However, LTE will not be enough. Operators will need to deploy many more base stations, especially in metro areas.
- Permitting and siting for metro sites is quite challenging, but new network technologies and architectures will help:
  - Small form factor base stations:
    - Remote Radio Heads (RRH), fiber connections w common baseband unit and passive enclosures
    - Software Defined Radio: multi-mode, multi band platforms
  - Pico base stations deployed as “underlay” with macro base stations



# LTE Commercial Deployments Status 2011

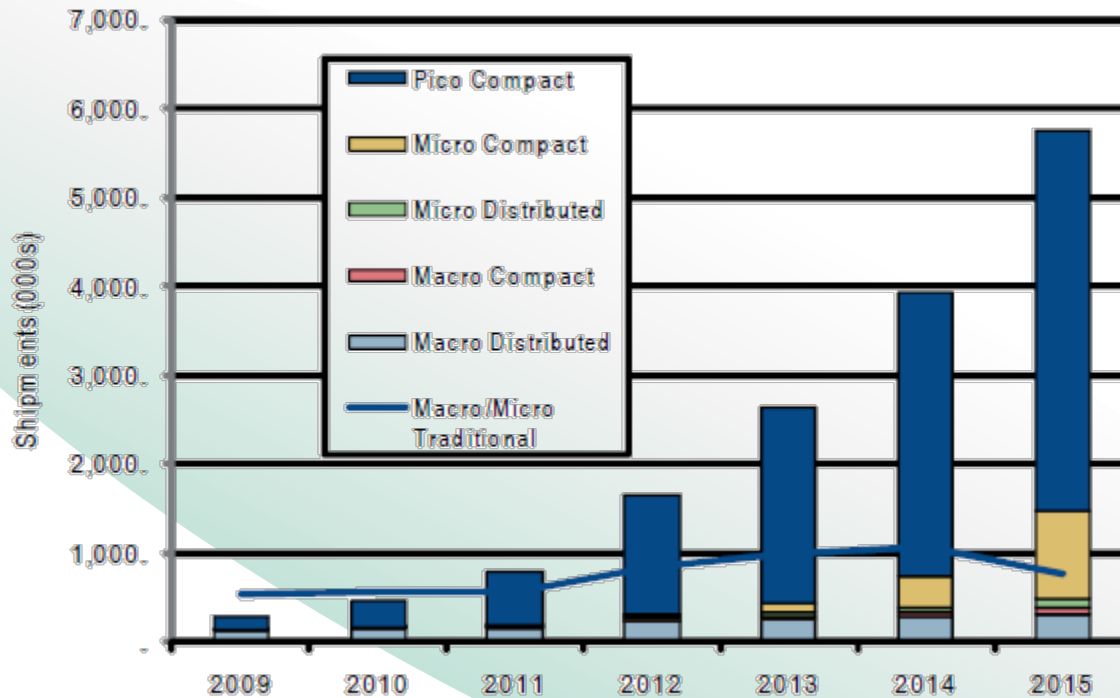
Region	Country	MNO LTE Deployments	Band	Date
N. America	USA	MetroPCS	AWS 1.7/2.1 GHz	2010
		Verizon Wireless	700 MHz	2010
		AT&T Mobility	700 MHz	2011
N. America	Canada	Rogers Wireless	AWS 1.7/	2011
		Bell Mobility	2.1 GHz	2011
W. Europe	Sweden	Telenor/Tele2	2.6 GHz	2009
		Telia Sonera	2.6 GHz	2009
W. Europe	Norway Finland Denmark	Telia Sonera	2.6 GHz	2010
			1.8 GHz	
W. Europe	Germany	Vodafone	2.6 GHz	2010
		Deutsche Telekom	1.8 GHz	
		Telefonica 02	800 MHz	
W. Europe	Austria	MA1 Telekom Austria	2.6 GHz	2011
E. Europe	Poland	CenterNet/Mobyland	1.8 GHz	2010
E. Europe	Estonia Lithuania Latvia	EMT	1.8 GHz	2010
		Omnitel		2011
		LMT		2011
Middle East	Saudi Arabia	Mobily	2.3 GHz	2011
		STC	1.8 GHz	2011
		Zain		2011
Central Asia	Uzbekistan	Mobile TeleSystems (MTS)	2.5-2.7 GHz	2010
		Ucell - TeliaSonera		2010
	Kazakhstan	Beeline/VimpelCom/KarTel	700 MHz	2011
Asia Pacific	Japan	NTT DOCOMO	2.1 GHz	2010
Asia Pacific	Hong Kong	CSL Limited	2.6 GHz	2010
Asia Pacific	Singapore	M1	1.8 & 2.6 GHz	2011
Asia Pacific	South Korea	SK Telecom	800 MHz/1.8 GHz	2011
		LG U+	2.1 GHz	2011

Source: Heavy Reading, GSA and Company Information

# Expanding Today's Networks creates Challenges

- **Site Acquisition:** Macro site expansion is very challenging. We are forecasting only a 3% increase in annual macro sites. Most new sites in metro areas will be pico cells. This deployment will be added wherever they can be. These small format base stations will be deployed below rooftop to facilitate placement and RF coverage.
- **Network Management:** Additional base stations means more network elements to manage. The LTE standard includes support for Self Optimizing Networks (SON), automating standard operations activities and enhancing remote control.
- **Backhaul:** Backhaul requirements are doubly affected:
  - Many more sites with a mix of native IP and circuit
  - The capacity of most sites is significantly increasing
  - *Backhaul has become the largest portion of technical op-ex and will keep growing*
- **Time to Market:** Operators have limited time to deploy new technologies. Deploying large numbers of pico-cells over the next 5 years will be quite challenging.
- **Total Operating Cost (TOC):** All cap-ex and op-ex must be managed carefully, as ARPU and capacity do not have a linear relationship. Operators very focused on servicing customer traffic without deteriorating operating margins.

# Pico Base Station Global Forecast



(Source: ABI Research, 2010, "The Emergence of Compact Base Stations in the new RAN Architecture Paradigm")

*Addressable Base Station type include Pico Compact and Micro Compact*

# 4G Partners Experience

- 4G Partners has looked extensively at evolving small cell network architectures aimed at solving capacity and coverage issues.
- We have performed network capacity simulations and studies that can be used by carriers for network planning and CapEx budgeting.
- We have also analyzed the deployment challenges, especially backhaul requirements and total cost of ownership.
- Small cells will be deployed at street level with at least 90% non-line-of-site backhaul requirements and up to 100Mb/s throughput requirements.
- Traditional microwave cannot meet these needs and the speed of deployment of fiber and copper are problematic.
- 4G Partners has looked extensively at utilizing non-traditional wireless frequencies to solve the non-line-of-sight issues.

# 4G partners Experience, p.2

- If you are a wireless carrier, new entrant, MAN fiber provider or DAS operator and interested in looking at ways to increase capacity, extend the reach of your present network or lower your total cost of ownership, we can support you.
- Our experienced team and suite of specialized tools are available to provide specific assistance to your firm.
- 4G Partners' Principals have been responsible for building several large wireless businesses and networks around the world and would like to help you meet your objectives.



**THANK YOU**

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