

Embedded GPS Timing at the Edge of the Network

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Outline

- Background
 - GPS Timing
 - Typical Implementations
- Evolving GPS Technology
 - Reduced Size
 - Lower Cost
 - High Sensitivity
- Embedded Applications
 - Established Environments
 - Emerging Edge Applications
 - Non-Telecom GPS Timing
- Directions Forward

GPS Timing Background

- GPS at the core of telecom timing
 - Atomic standards on satellites
 - Used to discipline local oscillators
- Typically distribution
 - BITS/SSUs in a CO
 - External GPS Receivers at field sites
- Recent GPS “Buzz” on LBS
 - Commercial/consumer applications
 - Market size has benefited timing applications

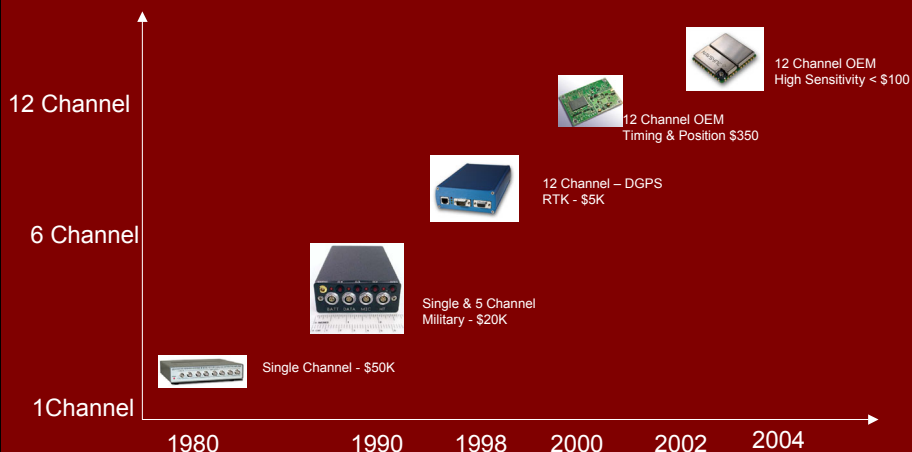
Evolving GPS Technology

- Three primary areas of improvement
 - Size
 - Cost
 - Sensitivity
- Size & Cost enable embedded solutions
- Improved sensitivity
 - Reduced implementation costs
 - Expanded use of GPS

Requirements for Embedded Timing

- Small Size
 - Surface mount module
 - Less than 250 sq mm footprint
- Economic Efficiency
 - Less than \$100
- Timing Accuracy
 - < 50 nsec accuracy to GPS time


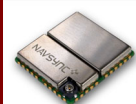
GPS Technology Evolution



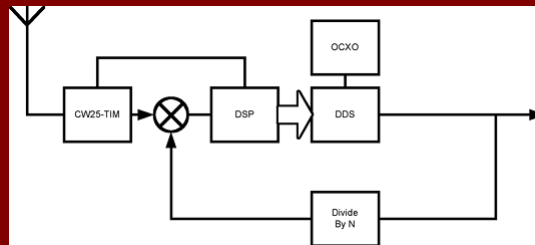
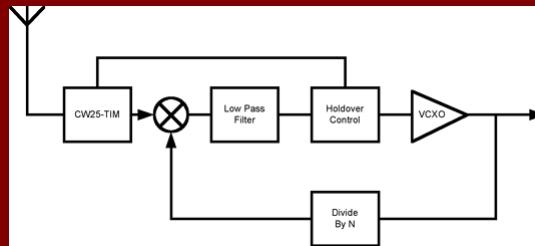
Desired attributes – Embedded GPS

- Programmable Frequency Output
 - 1 pps not always ideal for all applications
- High sensitivity
 - Reduce antenna costs (see later)
- Relatively clean output
 - Moderate jitter filtering only

Commercially Available OEM Receivers

Company	Model #	Size	Accuracy	
Motorola	M12+	40 x 60 x 10	12 nsec	
Navman	Jupiter PicoT	25 x 32 x 9	40 nsec	
Navsync	CW35-TIM	25 X 27 X 4	30 nsec	

Integrated Architectures



Application #1 – 2.5/3G Base Station Controllers

- Well developed over past several years
 - Interface with SONET/SDH
 - E-911 Mandates in North America
- Internal designs as well as module solutions
 - Modules such as Symmetricom BesTime
 - GPS Timing Receivers + OCXO for internal designs
- External GPS receivers still widely used
 - Trimble Thunderbolt
 - Symmetricom Star Loc

Application #2 – Edge Equipment

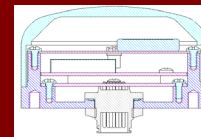
- Outside CO Environment
 - BITS/SSU not an option
- External GPS costly
 - Equipment
 - Installation
 - Maintenance
- Embedded solution enables OEM to offer value
- DSLAMs, Fixed wireless, FTTC/FTTH

Application #3 – CATV MSO

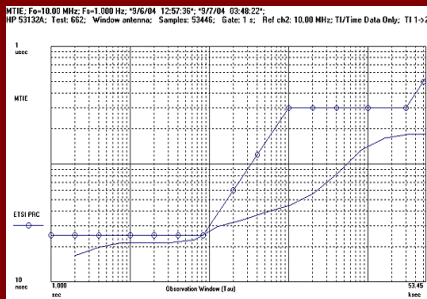
- Convergence with telecom sync requirements
- GPS & sync not a familiar topic for cable companies
- Embedded solution simplifies implementation

Application #4 – High Antenna Costs

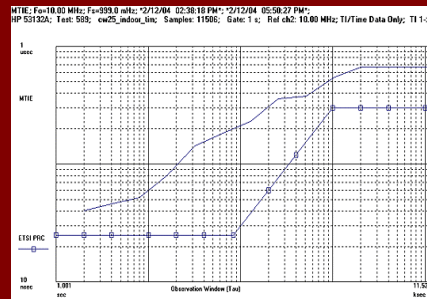
- Most installations use 40ft rule
 - Mount antenna at least 40 ft high
 - Limit sky blockage from building, trees, etc.
- New solutions offer low signal GPS tracking
 - Navsync to -155 dBm
 - Motorola to -150 dBm
- Reduce installation & maintenance costs
- Urban canyon savings even more
 - Antenna mounts on top of building
 - Rental space for antenna feed



Low Signal Environment Tests



Obstructed View



Deep in-building

- Results indicate antenna mounting costs can be reduced
- True indoor operation for timing still needs to be improved

Other Applications

- Portable Telecom Test Equipment
 - Indoor GPS helps
- NTP Servers
 - Growing Industry
- Digital Video Broadcast
 - Sync Video Frames
- Remote Telemetry
 - Utilities monitoring especially

Moving Forward

- New OEM GPS solutions available
 - Small, inexpensive, accurate, sensitive
 - Multiple suppliers available
- Equipment suppliers add value
 - Simple, economic GPS integration
- Carriers stand to gain
 - Stand-alone solutions still widely available
 - Embedded solutions open more options