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Loran Applications in Telecommunications Timing

by

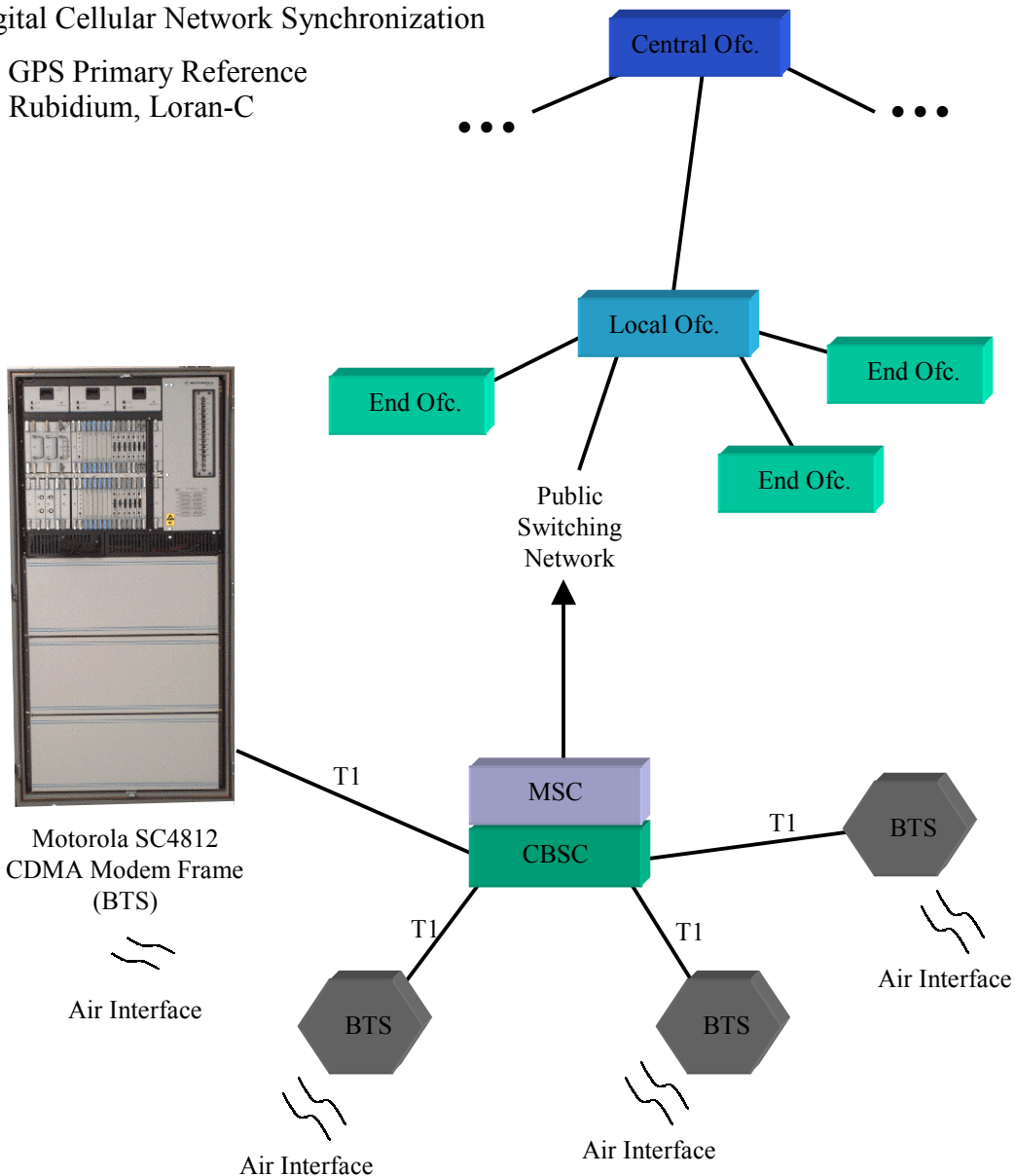
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Telecommunications Synchronization Overview

- Public Network Timing / Synchronization Architecture
 - Stratum Hierarchy
- Digital Cellular Network Synchronization
 - GPS Primary Reference
 - Rubidium, Loran-C





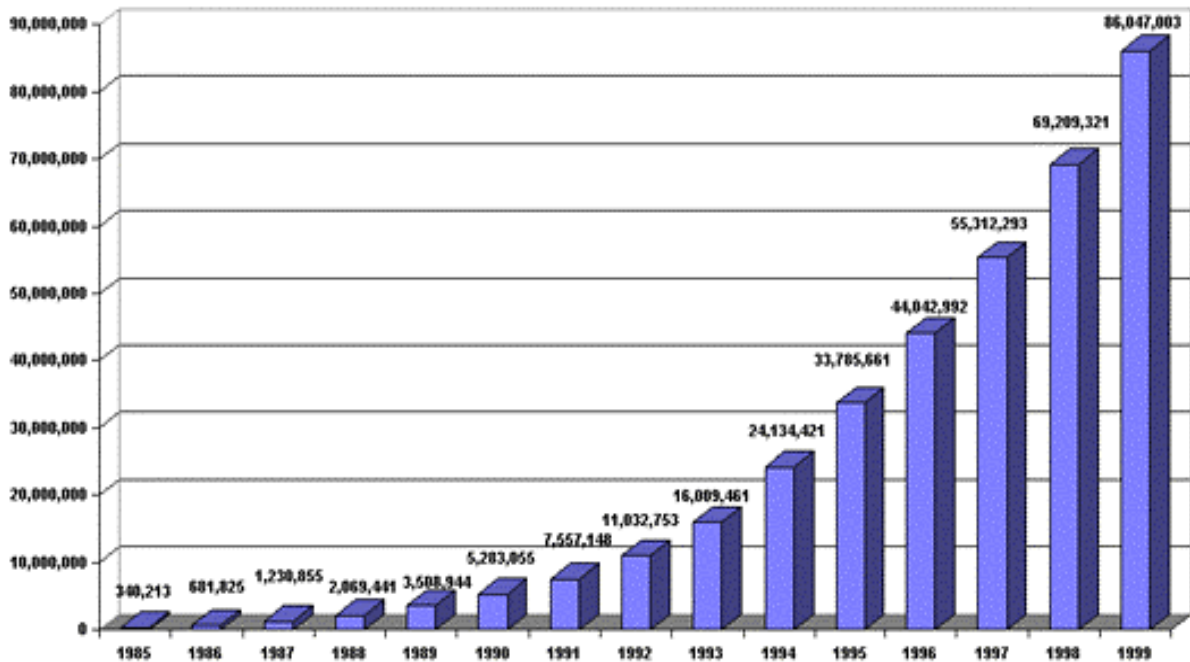
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Increasing Demands on Network Synchronization

- Rapidly Growing US User Base
 - Currently 103 Million US wireless subscribers

Growth of US Wireless Users

Wireless Subscribership: December 1985 - December 1999



Note: All data from Cellular Telecommunications Industry Association (CTIA) website, <http://www.wow-com.com/statsurv/> Data from CTIA Annualized Wireless Industry Data Survey Results, December 1985 to December 1999, reflecting domestic U.S. commercially-operational cellular, ESMR and PCS providers.

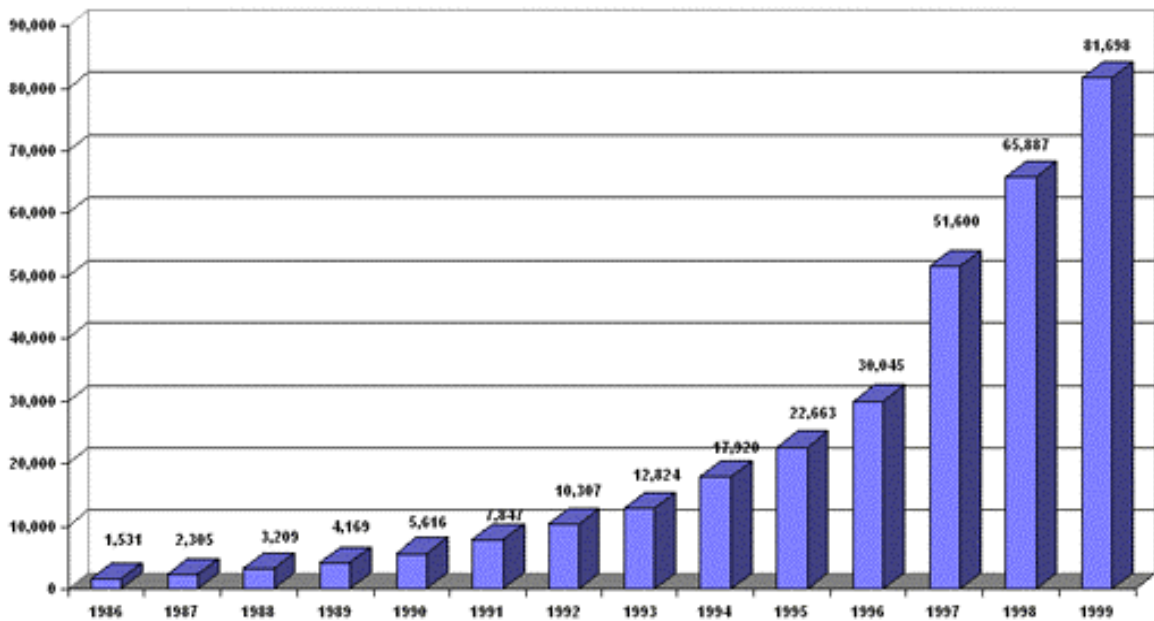


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- Associated Infrastructure (base station) Growth
 - Cumulative Capital Investment in US Infrastructure Equipment Exceeded \$71 Billion through 1999.

Associated Base-Station Growth in US

Cell Sites in Commercial Use: December 1986 - December 1999



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Increasing Need for Network Reliability

- Growing Dependency on Cellular
- Customer Expectation for Immediate / Reliable Safety and 911 Communications Using Wireless Services
 - In US (1999), over 118,000 emergency (9-1-1) calls placed daily, or 43 million annually

YEAR	Annually	Monthly	Daily
1985	193,333	16,111	530
1989	4,311,497	359,291	11,812
1994	17,910,620	1,492,552	49,070
1999	43,298,856	3,608,238	118,627

- Reliable Timing / Network Synchronization Essential
- Motorola “5-Nines” Network Robustness Initiative
- Availability / Reliability Issues Similar to Navigation Applications



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GPS Alone Cannot Provide Necessary Reliability

- Real Life Problems Encountered by Motorola Cellular Infrastructure Group
 - Unintentional Jamming
 - Television Stations
 - Spurious Emissions by Paging Transmitters
 - Unknown Sources
 - Intentional Jamming
 - US Government Tests
 - Poor Satellite Reception
 - Urban Canyons
 - Ice / Snow Buildup on Antennas
 - GPS Satellite Failures
 - Transmission of Errant Data
 - September 1995 (SVN10)
 - March 18, 1997 (SVN35)



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Telecommunication Systems Require Independent Backup Synchronization Source to GPS

- Loran Offers Excellent Solution –

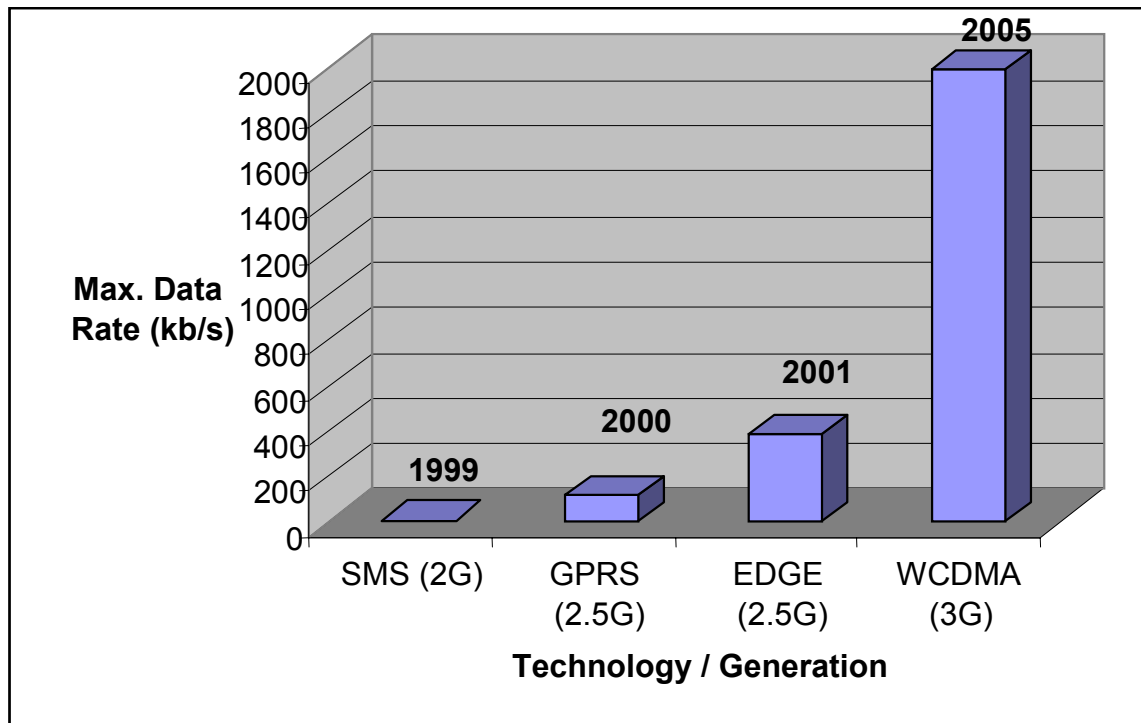
- Loran is Independent System
 - No common mode failures (e.g. unintentional jamming)
- Loran offers Performance Advantages
 - Penetration into Urban Environments
- Loran provides Infinite Backup Capabilities
 - Loran can Function as Primary Reference Clock (like GPS)
 - Rb alternative provides short-term redundancy only
- Loran is Only Other Source of UTC
 - Independent Source of UTC Required
 - Necessary for cell site start-up, when GPS might not be available
 - Integrity Monitoring
 - Rb alternative cannot provide UTC
- Loran Is Proven Technology with Established User Base
- Loran is Low Cost



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Future Synchronization Needs

- Increasing Bandwidth in New Generation Equipment and Associated Synchronization Improvements



- GPS and Loran can meet these more stringent performance requirements
- Independent Source of UTC
 - Loran can meet this need



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International Market Issues

- CDMA is US Technology and Motorola Provides CDMA Equipment
- Growing International Market for CDMA Equipment and New Generation CDMA Equipment

RPT-China Unicom Raises New Hopes for CDMA in China

Source: Reuters, September 5, 2000

“Chinese and foreign telecoms manufacturers, who would stand to earn Billions Of dollars selling CDMA equipment and handsets, said on Tuesday China Unicom had signalled it may build narrowband CDMA Networks as early as January.”

- Market Size Will Affect US Balance of Trade

China to Become World's Largest Phone Market

Source: Xinhua News Agency, September 10, 2000

“China will become the No. 1 telephone market in the world in five years.....
.....the number of fixed-line and mobile phone users is estimated to exceed 600 million in 2005....
.....the sales volume of China's electronic information products will amount to 1 trillion yuan (about 120 billion US dollars) this year, or 9 percent of the world's total. By 2005, the sales volume is expected to double the 2000 figure.”

- Major Telecommunication Markets (e.g. China) Will Not Accept GPS as Primary Reference Because of US Control
- Loran Provides Viable Primary Timing Reference for Some Major Markets (e.g. China)



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Summary

- Telecommunications Infrastructure Equipment is Major US and Global Market
- GPS is Typically the Primary Reference for Telecommunications Synchronization
- GPS Requires Independent Backup for Several Reasons
 - Rapidly Growing Market with Increasing Performance Requirements
 - Market Requires Increasing Reliability
 - Independent Source of UTC Needed
 - Supplier must Meet Market Requirements (Motorola “5-Nines”)
- Loran can be an independent backup to GPS and enable Motorola to meet its “5-Nines” commitment to its customers
 - Eliminates GPS Vulnerabilities (e.g. jamming, line-of-sight blockage)
 - Provides Independent Source of UTC
 - Provides Infinite Backup to GPS, even with Growing Performance Demands
 - Opens International Markets to CDMA Equipment (i.e. eliminates dependence on US controlled system)
- Loran can play an important role in the growing international market for CDMA equipment and associated exports of US telecommunications equipment.
- Motorola has formally endorsed Loran as GPS backup in letter to Secretary Slater



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