

## THE MARKET FOR SHORT-HAUL LINE-OF-SIGHT MILLIMETERWAVE TRANSMISSION LINKS

Cellular-Telephone-Distribution and Video-on-Demand in Europe

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**Abstract** - GSM type telephone systems have become a global standard today. In such a digital network, mobile CELLULAR-TELEPHONES communicate at 0.9 or 1.8 GHz within cell sizes of 1 to 20 km in diameter; groups of five to 20 of these cells have to be linked to a controller-station. This is the first *valuable niche market*, where millimeter radio fits in. Wireless CATV with projects like CellularVision, utilizing defined spectrum allocations at 28 and 42 GHz, respectively, are the basis for another upcoming market: VIDEO-ON-DEMAND, i.e. interactive television transmission and teleconferencing. This is the second *valuable niche market*, where millimeter radio fits in. The actual market situation - upcoming trends and development directions - with emphasis on Europe, will be reviewed in this paper.

### INTRODUCTION

Today the field of mobile communication is moving rapidly, GSM (Global System for Mobile communications) type telephone systems have become a worldwide standard. In such a digital network, mobile CELLULAR-TELEPHONES communicate at 0.9 or 1.8 GHz within cell sizes of 1 to 20 km in diameter; groups of five to 20 of these cells, i.e. transceiver base-stations, have to be linked to a controller-station. This is the first *valuable niche market*, where millimeter radio fits in, as digital mobile communication is the 'rising star', not only in Europe [1], but worldwide. Table 1 shows today's mobile communication distribution in some areas of this world [2].

Wireless CATV with projects like CellularVision - currently tested in Brooklyn, NY, USA and Hongkong - , utilizing defined spectrum allocations at 28 and 42 GHz, respectively, are the basis for another upcoming market: VIDEO-ON-DEMAND,

i.e. interactive television transmission and teleconferencing. This is the second *valuable niche market*, where millimeter radio fits in.

### SHORT-HAUL line-of-sight TRANSMISSION LINKS for PCN's

In Germany, for example, there are 2 million subscribers today within the three already existing digital mobile communication networks: D1, D2, and *eplus*. For the year 2,000 10 to 15 million users are previewed [2]. Taking into account the maximum capacity of the existing networks - D1 and D2 at 900 MHz having a capacity of 2 million user each, while *eplus* at 1,800 MHz provides space for 8 million users - a fourth digital network will be necessary to be licensed in the near future; preparations have started already [3].

Due to flexibility reasons and based on the important demand of a quick installation time *short-haul line-of-sight transmission links* are very advantageous for connecting the base stations of such PCN's with their corresponding switching centers [4], fig. 1. Depending on the hop length being necessary topologywise, the use of 23, 38, 55 or 58 GHz links is appropriate. Table 2 shows the corresponding Channel Plan and Equipment Regulatory Specifications, being proposed in 1990 by the Radiocommunication Agency of London, UK [5], which today is commonly used as a general standard for industry in countries where no official frequency assignment is available yet.

As an example, a total requirement of 16, 000 38 GHz-T/R-units can be estimated to be necessary for the German DCS 1800 mobile telephone

network, *eplus*, before completion of the installation in 1998; more than 2,500 units are installed already. Starting with an estimated number of 8,000 to 10,000 base stations to cover all of Germany, 85 % of which will be wirelessly connected and 80 % of these wireless connections will be at 38 GHz (German topology), with a redundancy factor of 30 % and two frontends per transmission link, the above number can be calculated. Spare units for maintenance and redundancy for 'hot spots' are not taken into account yet, as special re-routing capabilities might enlarge this number even further.

This is just one provider network. While the network provider of the German D2 network -Mannesmann - has just joined with Skoda (Cz) to apply for the license of the first czech GSM network [6], one of the major stakeholders of *eplus* - Thyssen Steel - is part of the consortium to build the french DCS 1,800 network, starting in 1996. As of October 1994, at least 92 GSM systems were operational or in 'status nascendi' worldwide [7].

## WIRELESS CABLE and VIDEO-ON-DEMAND

Unlike conventional cable, "wireless cable" systems do not require hardwired infrastructure or signal amplification. The system uses an addressable, multichannel, high-frequency signals, operating along a line-of-sight path to a customer's antenna. Using, e.g. the 27.5 to 29.5 GHz band, a virtually unused segment of the spectrum previously reserved for point-to-point commercial networks, CellularVision of New York (Freehold, NJ) is currently providing a point-to-multipoint distribution system with 49 video channels in the Brighton Beach section of Brooklyn. The system uses a 12.7 cm flat plate antenna at the user's premises. Service prices are significantly lower than that of cable [8]. For services in Europe a frequency of 42 GHz has been provided.

## TECHNOLOGY and REALIZATION

Until today in most cases hybrid millimeterwave technology is employed predominantly. However, MMIC technology is incorporated now, as it has become available. A good example of the earlier is

*millimeterwave radio type 40 DR* - delivered to **northern telecom Europe, Ltd.** of Paignton [9], England and manufactured by MRC (Microwave Radio Corporation), a subsidiary of California Microwave in the US.

A MMIC based system, like the *millimeterwave radio type MDL 38*, has been delivered by **Philips-TRT** of Paris, France [10], and is one of the first 38 GHz systems for applications requiring connection of 1 to 4 x 2.048 Mbit/s bit streams. It is homologated and in service in various countries worldwide (e.g. Europe, Oceania and Latin America).

Another MMIC based system, the *millimeterwave radio type S3000 - 38*, built by **Hughes Communication** of Torrance, CA, USA, is part of a line of fully integrated millimeterwave transceiver products, designed specifically for wireless data and voice communication applications. Using 64 QAM/SONET type modulation, up to 154 Mbit/s bit streams can be transmitted over a maximum range of 10 miles [13].

**Alpha Industries** of Methuen, MA, USA, the major MMIC chip supplier in this field nowadays has shipped more than 2,000 monolithic 38 GHz chip-sets worldwide in 1994, with an actual shipping rate of 700 per month in autumn 1995 [11]. Fig. 2 displays the unique situation of Alpha Industries as a key-player in this field - providing 38 GHz chip-sets for most of the major equipment manufacturers [12].

## CONCLUSION

The actual market situation and the foreseeable future trends - Hughes, for example, estimates a worldwide demand of about 200,000 to 250,000 units until the end of 1998 [13], while Siemens evaluated the "component quantities required" to "about 10 K per system and frequency in Europe" [14] - clearly shows the large market of Cellular-Telephone-Distribution and Video-on-Demand for short-haul line-of-sight millimeterwave transmission links.

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## REFERENCES

- [1] Daniels, G.: The European market for digital cellular communications, Special Report, Microwave Journal, Jan. 1993, 66-80.
- [2] Wirtschaftswoche, No. 42 / 48, 1994.
- [3] Süddeutsche Zeitung, No. 262, 14 November 1995, Commercial Affairs News, 19.
- [4] Meinel, H.: Commercial application of millimeterwaves - history, present status and future trends, IEEE Trans. MTT-43, No. 7, July 1995, 1639-1653.
- [5] Business Opportunities in the Millimetric Bands, Seminar of the EEA & RA, London 27th June 1990.
- [6] Süddeutsche Zeitung, No. 264, 16 November 1995, Commercial Affairs News, 23.
- [7] Personal communication services and GSM applications, Special Report, Communicationsweek International, 10 Oct. 1994, 10-11, 22-26.
- [8] Schneiderman, R.: Vendor picture brightens in wireless cable television, Microwaves & RF, September 1993, 42 - 44.
- [9] nt - Northern Telecom Europe Ltd., data sheet 1992: 40 DR, 38 GHz Digital Millimetric Radio.
- [10] Brillard, J.N., Marchand, P., Pereira, E.: MDL 38: 38 GHz radio transmission system for urban links, Communications & Transmissions, No. 4, 1993.
- [11] Rafaelli, L., Stewart, E.: A standard monolithic transmitter for 38 GHz PCN applications, Microwave Journal, February 1992.
- [12] Stewart, E., Alpha Industries Inc.: private communication.
- [13] Giguere, D., Hughes Communication Products: private communication.
- [14] Pettenpaul, E., Schöpf, K.J.: State-of-the-art semiconductor devices for mobile communication systems in Europe, IEEE NTC '95, The Microwave Systems Conf., Orlando, FL, paper 3B-1, 65-72.

Germany	2.5 %
England / USA	6 %
Skandinavia	10 %
Hongkong / Singapore	30 %

Table 1: Mobile communication distribution today from [1]

TRAFFIC CAPACITY	Frequency		
	38 GHz	55GHz	58GHz
Channel	25	100	
2 Mbit/sec	14	25	100
8 Mbit/sec	28	50	100
34 Mbit/sec	56	75	100
140 /155 Mbit/sec	140	150	tbd
Narrowband TV	28	tbd	100
Colour TV / Radar Remoting	56	tbd	100
GO/RETURN Spacing (MHz)	1260	> 500	N/A
Frequency Stability (+/- MHz)	4	9	36

Table 2: Channel plan and equipment regulatory specifications from [5]

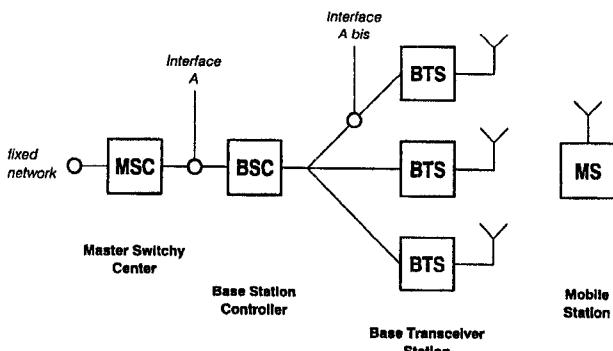


Figure 1: Network architecture for a GSM type system

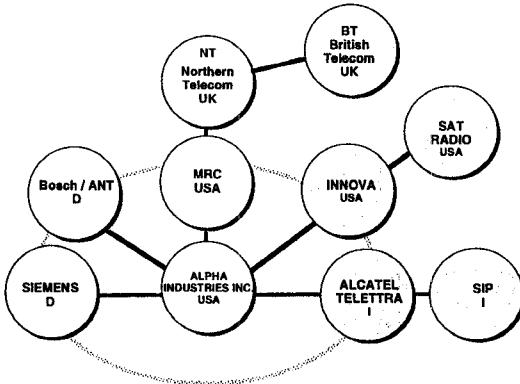


Figure 2: 38 GHz short-haul transmission-links worldwide key-players and their connection to Alpha-Industries

