Whitepaper: MultiFlex

A deeper look into Repeatit's game changing new feature to the Trinity product range.

MultiFlex is a new feature in the Trinity range that enables each Trinity unit to have Point to Multipoint functionality. The feature also allows PtMP to be synchronized with PtP enabling ultra-high performance with smart channel re-use in congested 5GHz environments.

For more information, please visit http://www.repeatit.se/products/trinity/multiflex/.

A fixed wireless Point to Multipoint (PtMP) system consists of a base station (master unit) and a number of client units. The normal application area for such a system is to provide wireless 5 GHz & 3 GHz backhaul to CCTV cameras, ISP & Carrier backhaul, Campus Connectivity IP and border control in dense and congested environments.

The MultiFlex solution that is described in this document is what we refer to as a Point to Few (PtF) system. It differs from a PtMP system as it is limited to a fixed number of connected clients per base station. The limitation is set in order for the system to guarantee low latency, low jitter and high bandwidth to all connected clients with our Repeatit AirTime access protocol.

When comparing various PtMP and PtF systems in the market, there are a number of other things to look out for:

1) If the equipment that comes in both ends of the system (client and base station) is provided by the same vendor, it gives much more flexibility and options in the way bandwidth, quality of service (QoS) and radio settings can be optimized. Software upgrades can be simultaneously scheduled and are handled in a single point with a single tool for the entire network.

2) The equipment can be "consumer grade" or "carrier grade". Carrier grade equipment normally comes with proven high availability and quality of the hardware and software.

3) A lot of existing PtMP systems are based on plain 802.11a/n/ac access. This means that the radio uses a contention based access protocol which results in unstable and unpredictable link performance. It also means that total system throughput is obtained by using very wide frequency channels. This does not only expose the links for interference in various forms, it is also polluting spectrum and making it harder for concurrent (or own) systems to perform simultaneously.

4) Repeatit provides GPS synchronization per site and between sites. The same synchronization source is used for both PtF and PtP equipment. This results in extremely good spectrum efficiency and optimized channel reuse (the same channel can be used by a lot of equipment in the same tower without problems). This functionality is not available in many PtMP (or PtF) systems in the market but it is crucial for link performance and sustainability.

5) A comprehensive and centralized management system that gives the operator full control of the network is a must for all network owners. Many PtMP solutions do not offer this.

Repeatit provides all of this in an installed base of over 840,000 units in more than 50 countries over the world.

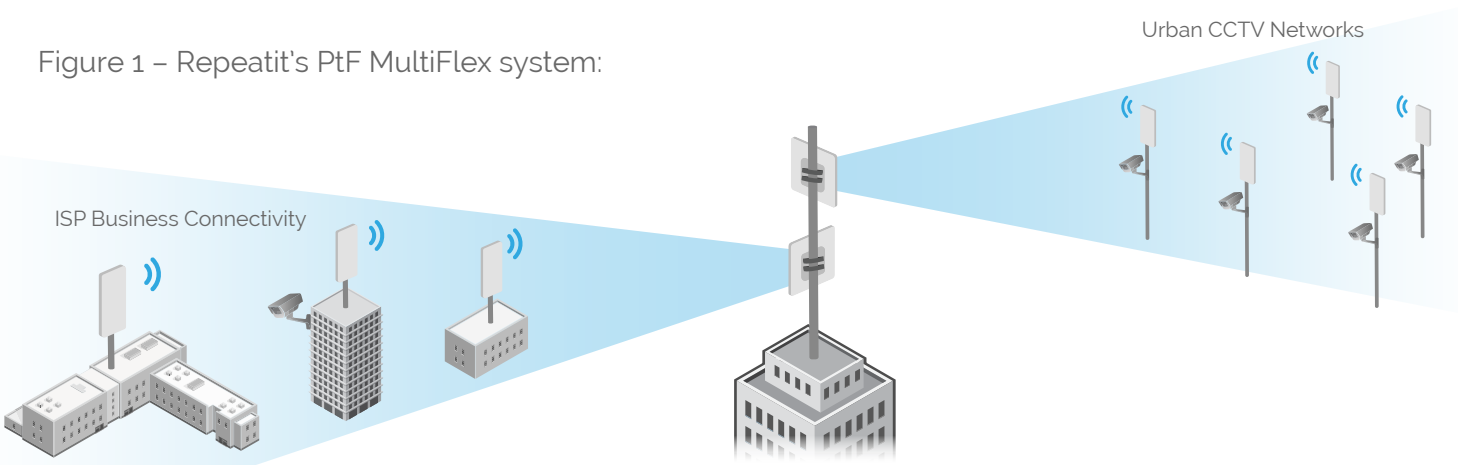
What is Repeatit's MultiFlex Point to Few system about?

As mentioned above, Repeatit's MultiFlex PtMP solution is actually a Point to Few (PtF) system. This means that the number of subscriber units that can connect to the Base Station unit is maximum eight (8). This results in a highly available and reliable PtMP concept where the clients can enjoy guaranteed bandwidth.

The MultiFlex system contains four main building blocks:

1) The Base Station
2) The Subscriber unit
3) The Repeatit AirTime access protocol
4) The server based Radio Control Software (RCS) or alternatively The Repeatit Cloud

Figure 1 – Repeatit's PtF MultiFlex system:



Base Station

The Base Station (BS) is used to provide connectivity for the Subscriber Units (SUs) and it is mounted in a place which fulfills two main criteria:

1) It is a point where transmission (either wired or from a backhaul wireless link) and power can be provided.

2) From the mounting point of the BS antenna(s), free Line Of Sight (LOS) is required to all Subscriber Units (SUs) receiver antennas. Some vendors claim they provide Non Line Of Sight (NLOS) in unlicensed frequency bands. Repeatit strongly dissuades from building NLOS networks as it often drives OPEX and increases churn. Near LOS sometimes works, but in most cases with degraded

performance, higher OPEX and higher churn.

The BS units can come with integrated sector antennas or external antenna connectors. Integrated antennas result in simpler and faster installations, cheaper site rent and less cable-related problems. In both cases Repeatit designed the Base Stations and Subscriber Units to have a very small form factor in order to save mast space and allow challenging installations e.g. on lamp posts at street level to backhaul CCTV cameras.

Subscriber Units

The Subscriber Units (SUs) are mounted on the rooftop of all buildings or in other high locations close to where equipment (like cameras) should be backhauled. The antenna(s) of the SU should face the BS antenna. The maximum obtainable physical range between an SU and the BS is mainly defined by these factors:

1) Antenna gain used on both sides. Repeatit provides BS and SU units with integrated or external antennas with various antenna gain to allow for flexibility.

2) Equivalent Isotropic Radiated Power (EIRP) which (a bit simplified) is the conducted output power from the radio chipset plus the antenna gain. The allowed EIRP is dependent on regional regulations.

3) Frequency used. Repeatit supports 5GHz operation in all our MultiFlex nodes and 3.5GHz in some.

4) Offered services to the end users in the MultiFlex system.

5) Number of connected users.

As each BS has a common bucket of resources to share between its SUs, it is important that the link budget is optimized for all end users. Please refer to Repeatit's Deployment Guideline document for more reading on link budgets, Line Of Sight and Fresnel zones.

The Repeatit AirTime Access Protocol and SyncMaster

Repeatit's AirTime protocol is essentially taking charge of the wireless medium to decide when to transmit/receive packets. This results in very predictable and stable link performance for both PtP and PtF Trinity units. In essence, the AirTime protocol divides the air time into time slots which are assigned to the Master/Client units in a selected scheme.

If more units are deployed in the same site, for example a couple of links and a MultiFlex Base Station that backhauls a number of surveillance cameras, Repeatit's SyncMaster solution can be added to the configuration. What the SyncMaster does is aligning the transmission/receiving (Tx/Rx) windows for all units. Given a careful antenna installation, this results in that all units can operate on the very same frequency channel without problems.

Note that the SyncMaster is not required for the Trinity PtP/PtF systems to work, but it enhances spectrum efficiency and link stability while not compromising on latency or throughput.

MultiFlex Product Design and Solutions

The MultiFlex solution was developed with legacy Repeatit products in mind. Every Trinity unit that has been shipped since 2013 can be upgraded for free to either a MultiFlex BS or a MultiFlex SU. This allows for very high flexibility when choosing antenna configurations. The MultiFlex BS/SU portfolio also comes with two new Trinity family members. Both of them follow the traditional Repeatit product design where we always strive to integrate antennas into the radio units in order to simplify installation, reduce the footprint in antenna masts remove the need for and problems with external antenna

cables. The result is reduced CAPEX and OPEX.

The building blocks of the MultiFlex solution are described in the sections below.

Base Station and Subscriber Unit options

All Trinity nodes are outdoor classified and will support the MultiFlex software. This means that both the Base Station and Subscriber Unit configuration runs on any existing hardware models shipped since 2013. In addition, a new MultiFlex Base Station with integrated 16dBi 90 degree antenna has been developed. It can also run in SU mode if required.

A new MultiFlex SU is also released (Trinity 216-SU). This is the only Trinity product that only can operate in SU (client) mode. The table below holds a summary of the existing units.

Product	Supported Mode(s)	Antenna Configuration
Trinity 316	PTP/BS/SU	Integrated 16dBi dual-polarized
Trinity 318	PTP/BS/SU	Integrated 18dBi dual-polarized
Trinity 323	PTP/BS/SU	Integrated 23dBi dual-polarized
Trinity 300	PTP/BS/SU	2 external N-connectors
Trinity BS340 (New!)	BS/SU	Integrated 16dBi dual-polarized, 90 degrees sector
Trinity SU216 (New!)	SU only	Integrated 16dBi dual-polarized

The new Trinity-BS340 unit comes with a number of benefits compared to many traditional PtMP Base Stations. The integrated sector antenna reduces the antenna mast footprint, removes the need for external antenna cabling and makes installation simple and fast.

SyncMaster Considerations

As described earlier in this document, the SyncMaster is often the difference between taking control or losing control over a site. It allows the network owner to use much fewer channels and be spectrum efficient, and both link equipment and multipoint (PtF) equipment can use the same SyncMaster to achieve this.

Operating in unlicensed frequency bands means restrictions in output power and potentially high interference levels. To make your installation tolerant to interference and noise, make sure to plan out the network carefully with Line Of Sight (LOS) and free Freznel zones where possible. Repeatit also strongly recommends using the SyncMaster in all locations that are subject to interference.

The Repeatit AirTime Protocol

The AirTime protocol divides the available resources among the BS and all connected SUs, so that every user is guaranteed their fair share of bandwidth. The allocation does not have to be equal for all SUs or even equal in uplink/downlink directions. There might for example be a scenario where some surveillance cameras get a couple of uplink timeslots each while an office building (handled by the same Base Station) gets ten times more capacity for Internet connectivity. The AirTime protocol creates a highly scalable and flexible environment that supports any type of multipoint scenario.

When combined with the SyncMaster, each Trinity unit (operating in PtP link or MultiFlex PtF mode) aligns the Tx and Rx windows so transmission is done synchronously per site. This effectively removes in-band interference from any Repeatit equipment operating on the same channel and the result is state of the art spectrum efficiency.

Software Upgrades and Management System Support

Repeatit provides software upgrades for free to all its customers. The simple reason for this is that we

want happy customers with best performing networks. Trinity links shipped 2013 or later support the MultiFlex SW and can be upgraded for free to support PtF configurations.
Repeatit's Trinity nodes can be managed by either the server based Radio Control Software (RCS) or The Repeatit Cloud service. Both are free of charge and constantly developed to provide Configuration Management, Fault Management, Software Management, Performance Management and Self-Organizing Network (SON) features.