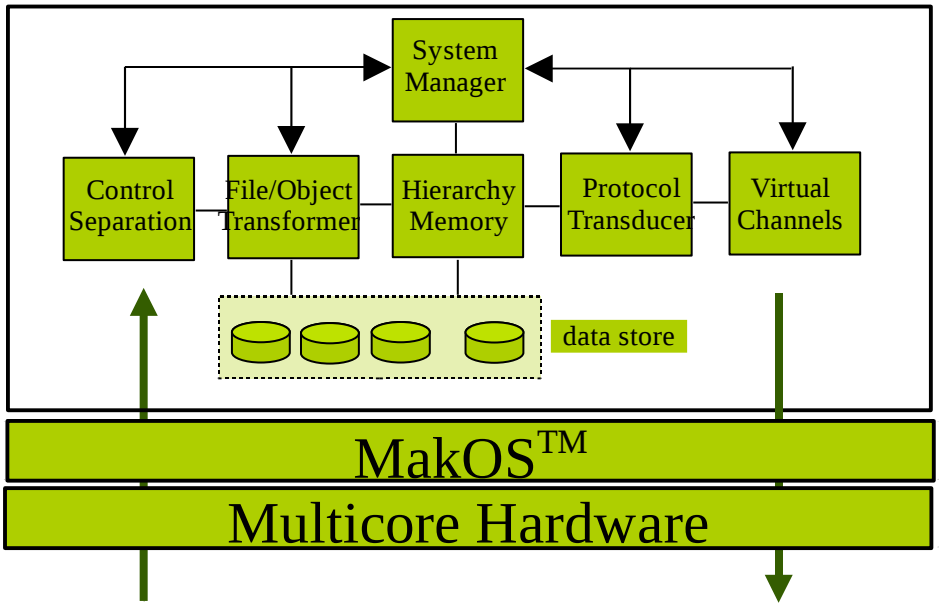
Makani WAN Optimization

To make the WAN behave fundamentally like a LAN requires a combination of compression and caching, while speeding up transport and application protocols. At the heart of Makani's solution is the **Makani Latency Buster™** — a revolutionary software architecture consisting of 5 key building blocks:

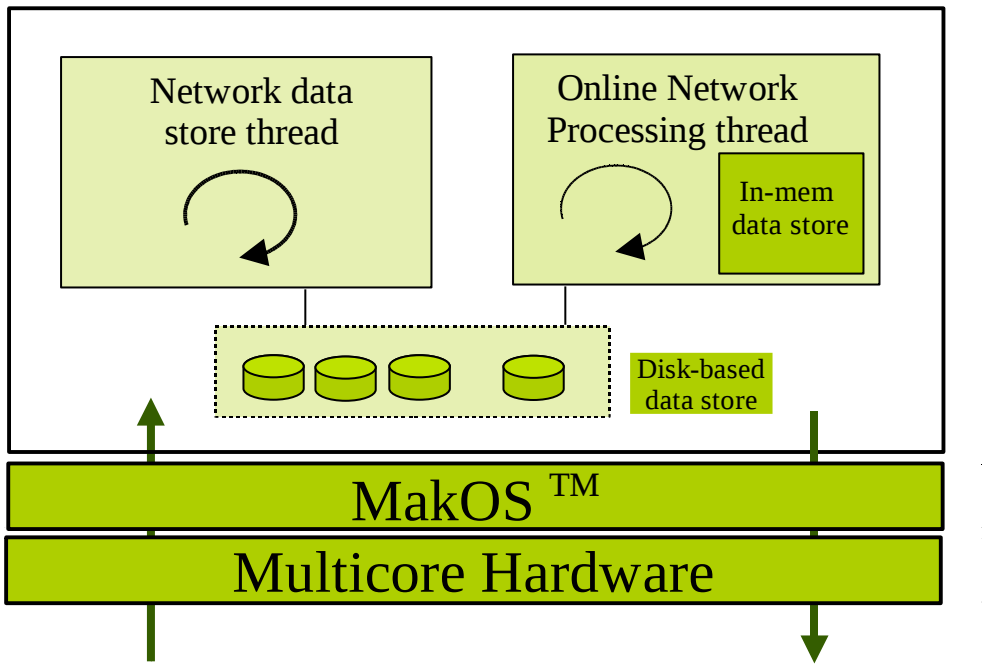


Architecture of Makani WAN Optimization appliance

- **Split Control-Plane:** Makani decouples control from the data path. By separating control from data, Makani delivers a breakthrough system architecture that is highly optimized for both control and data.
- **File Transformers:** Unlike generic compressors, File or Object Transformers correlate objects at the information level and employ patent-pending algorithms to remove redundancy that gets the best storage, bandwidth, and latency savings.
- **Virtual Channels Abstraction:** Virtual Channels is a high-level resource abstraction that enable fine-grained QoS control to offer the fastest acceleration for real-time and business critical data.
- **Protocol Transducers:** Makani optimizes and accelerates protocols at all levels. Besides TCP window resizing and other transport layer optimizations, a patent-pending “Async Messaging Layer” is employed that mitigates app and protocol chattiness and round-trips to deliver substantial reduction in latency.
- **Hierarchical Caching Technology:** By employing object- and byte-level data store with hierarchical hash technology, Makani detects data duplicates leading to significant bandwidth savings and manifold reductions in application latency.

Adaptive-Learning Bandwidth Optimization

Adaptive bandwidth optimization for Makani starts with the premise of being application aware. By understanding the fundamental characteristics of specific apps like an email program or a web browser or an enterprise application, and by learning about the network link characteristics, you can make intelligent decisions on how to streamline an application for optimal delivery. Adaptive-Learning optimization starts by identifying the application and the network, understanding the inherent properties and the data model of that application, and then applying application and network-specific techniques to optimize link bandwidth. It is not just about traditional compression but an intelligent set of operations triggered by first identifying the type of the application and learning about the network.



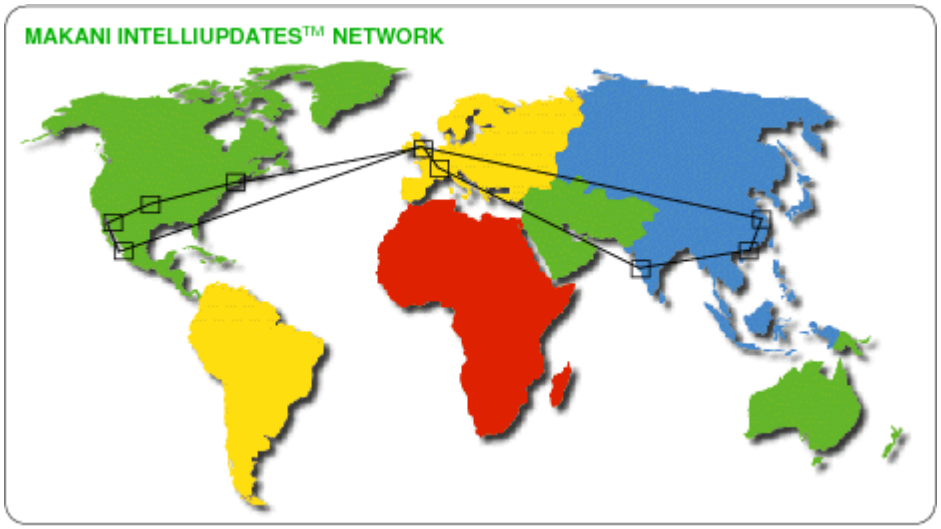
Makani decouples I/O-intensive network data storage from network data processing

MakOS™ Operating System

Makani appliances builds on the power of a customized Linux operating system. The MakOS™ architecture offers a **"software bus or backplane"—**style construct that is highly distributed and designed to provide high availability, flexibility, and performance. The MakOS™ achieves this by dividing up the processing into distributed modular, light-weight "processes" that separates, for instance, online network data processing from I/O-intensive network data disk-based storage. By judiciously distributing load of the group of processes across all processors in the system, overall performance is significantly improved and latency is reduced. The distributed design provides exceptional performance, ease of management, and service protection while fault containment significantly limits impact when a fault occurs.

Makani Global IntelliUpdates™ Network

Makani appliances harness the power of Makani's global IntelliUpdates™ Network, the world's first online traffic and diagnostic tracking database. The IntelliUpdates Network is a global network of data centers that continually captures data from each Makani appliances deployed worldwide, providing a large information base of customers traffic patterns and device diagnostic information. Customers traffic patterns and device diagnostic data are continuously analyzed, and appliance reconfiguration data and updates/upgrades or patches are remotely provisioned to fine-tune the Makani appliance to deliver the max performance on the network.



Makani Gobal IntelliUpdates™ network

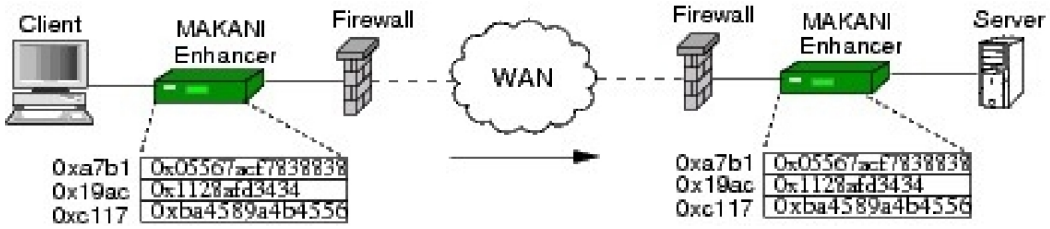
Smart Appliance Management™

Makani appliances are "future proof" appliances in that they can be flexibly customized, remotely diagnosed and easily reconfigured to suit the requirements of each customer. Smart Appliance Management™ technology enables dynamic reconfiguration of appliances with software updates/upgrades or patches that can potentially add new features or functionality or even fix bugs within the device. Thus, if a customers network traffic patterns change or if there are any problems within the device, then using SAM™ technology we can remotely reconfigure the appliance and adapt it to the new traffic patterns or application requirements, or simply fix the bugs. Indeed, Makani's SAM™ technology in conjunction with the IntelliUpdates™ Network helps eliminate tremendous amounts of IT management.

Increasing WAN Capacity with Hierarchical Memory®

At the heart of Makani solution is a hierarchical memory technology that offers patented compression and caching to gain instant WAN capacity on the existing network. Two techniques here are crucial:

- **Online Byte Reduction™ (OBR™)** technology, which uses a highly efficient in-memory based pattern dictionary to detect and eliminate data repetitions that occur across a range of applications. Depending on the application mix, many fold increase in capacity on existing WAN links is realized by eliminating repetitious data with a small compressed token (called rabin chunk hash); in some cases as much as a 5x-100x increase.
- **Network Byte Caching™ (NBC™)** technology, which dramatically increases WAN capacity by recognizing much larger data patterns than OBR™ compression. This technology relies on embedded hard disks to store longer data patterns for longer periods of time, replacing them with a token for transmission over the WAN.



Makani replaces longer data patterns with a hash (fingerprint)

Traditional file caching is designed to eliminate large redundant file transmissions, but it often fails to deliver because of two key limitations. First, file caching works only on a single application; because enterprises have a heterogeneous mix of applications, the overall impact that file caching has on reducing WAN transmissions is limited. Second, file caching operates only on exactly repeated files. In contrast, Makani's NBC™ technique recognizes repeated data patterns and eliminates them, even when a file has been modified. In addition, the use of on-board hard disks provide tens to hundreds of gigabytes of persistent storage; hence sequences seen several days earlier can be eliminated.

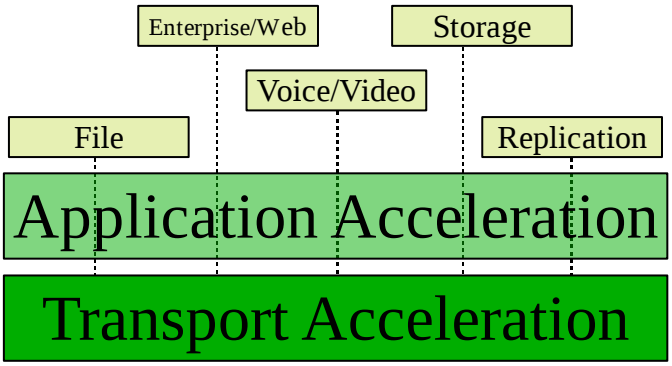
A key attribute of OBR™ technology is its compression capabilities even on very large amounts of bandwidth. These attributes are traditionally mutually exclusive when using compression techniques such as Lempel-Ziv, or its derivatives.

Online Byte Reduction and Network Byte Caching techniques reduce traffic for *any* IP traffic — not just TCP. The efficiency of traditional compression is limited, since they can buffer only a limited number of repeated patterns. In contrast, Online Byte Reduction and Network Byte Caching techniques store many more and longer repeated data that dramatically reduce traffic flows while adding only a negligible amount of latency.

Bottom Line: *The compression capabilities in Makani platforms work across the broad spectrum of repeated data pattern sizes and dramatically increase the capacity of WAN links.*

Application and Protocol Optimizations

Latency affects application performance because the underlying protocols and applications rely on a back-and-forth sequence of data transmissions and acknowledgments.



Makani accelerates a broad range of apps and transport protocols

An application acceleration platform requires both TCP acceleration to benefit a broad range of applications and app-specific acceleration to speed applications whose Layer-7 protocols are less efficient than TCP. The Fast Startup™ technique improves the performance of short-lived connections, speeding up apps that use chatty protocols. The Flow Streamlining™ technique accelerates TCP performance by streamlining TCP connections using a more efficient transport protocol between devices. This feature significantly benefits performance on high-latency connections.

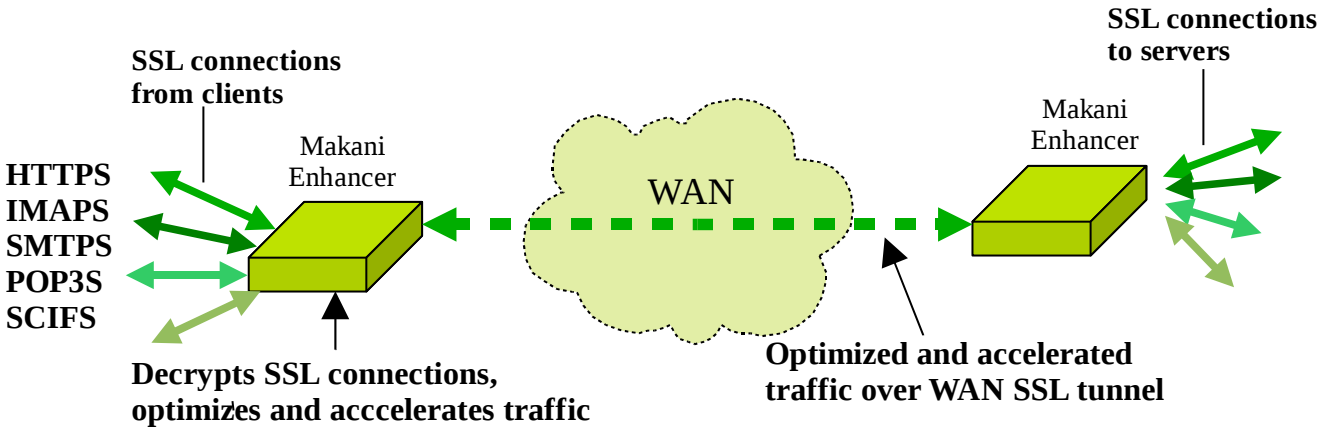
Certain applications can't benefit from TCP acceleration until they are accelerated at the application layer, at which point application-specific acceleration and TCP acceleration provide a compound performance improvement. The Makani's Application Acceleration™ (AAC™) technology accelerates the underlying protocols of these applications: the **Messaging Application Programming Interface (MAPI)** used by Microsoft Exchange; the **Common Internet File System (CIFS)** at the heart of Microsoft file services; and HTTP for web applications. In the case of Exchange and file services, their underlying protocols send data in small blocks and require an acknowledgment for each, resulting in hundreds or even thousands of RTTs to complete a single transaction. As a result, performance drops dramatically when used across a WAN link with even modest latency — 20 ms or 30 ms — resulting in user frustration and lower productivity. For web applications, HTTP requests objects one at a time, so dozens of RTTs are needed to load a single web page, again impacting user productivity.

The AAC™ technology accelerates these applications using a number of application-specific techniques: aggressive read-ahead and write-back for CIFS/MAPI, object caching, pipelined data blocks and web objects, deterministic on-demand link prefetching, preemptive DNS resolution, read-ahead range offset requests, and web meta-data acceleration. Collectively, these techniques deliver up to a 50-fold improvement in app performance including enterprise applications like SAP Netweaver, Oracle, Peoplesoft/JD Edwards, Microsoft or Siebel CRM, Sharepoint, OWA or other web-based applications at the same time helping increasing content availability but without compromising consistency.

Bottom Line: *Makani platforms enhance performance across a broad range of application types and WAN link characteristics; improve user productivity; and enable deployment of new applications that previously could not run across a WAN.*

Security and SSL Acceleration

Makani appliances are designed to accelerate traffic that are encrypted using SSL. Makani appliances do so by applying all of the same set of optimizations they apply to unencrypted traffic over the WAN. Makani accomplishes this while maintaining complete end-to-end security and maintaining the trust model that enterprises require. The breakthrough approach from Makani allows end-to-end secure traffic and secure WAN traffic optimization and acceleration that offer LAN-like performance over the WAN. Each client uses unchanged server addresses and each server uses unchanged client addresses; no application changes or explicit proxy configuration is required.



In an ordinary SSL handshake, the client and server first establish identity using public-key cryptography, then negotiate a symmetric “session” key to be used for data transfer. Using Makani platform, the initial SSL message exchanges take place between the client and the client-side Makani appliance, which initiates a connection with the server-side Makani appliance. The server-side Makani appliance then sets up a SSL connection to the server to satisfy the client request. The net effect is that the client's SSL connection logically terminates at the server, but physically terminates at the client-side Makani appliance. The approach is completely transparent to the user or application.

This powerful form of SSL acceleration gives enterprises new, better choices in the security vs acceleration tradeoff. With Makani's approach to end-to-end SSL traffic acceleration, enterprises may choose to mitigate more of their applications to SSL-encrypted protocols to give them the data security they are looking for. With Makani, they can be assured that their distributed workforce can still access the information they need at LAN-like speeds, no matter where in the world their office is located.

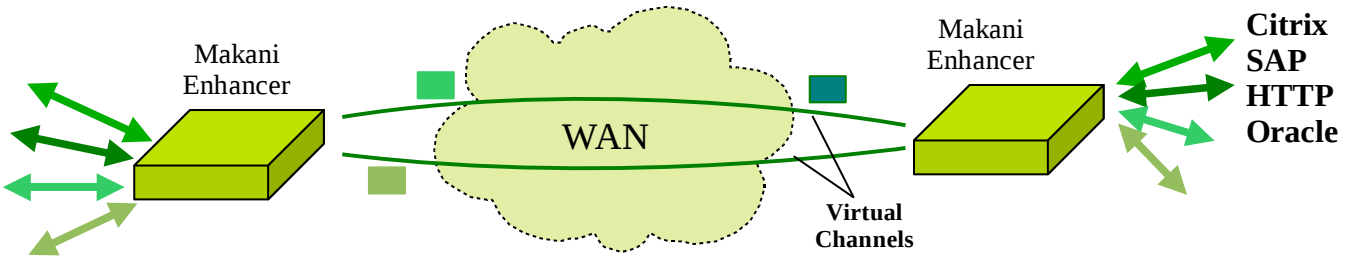
The Makani platforms also ensure the security of their network data transmissions. With Makani platforms one can optionally deploy a standards-based IPsec encryption feature in sites without a VPN deployment, securing data sent over unsecure links such as the Internet or satellite and also securing device-to-device communications.

Bottom Line: *Makani Networks platform accelerates and optimizes encrypted (SSL) content and provides a wide range of security features needed to ensure appropriate access and secure transmission of data.*

QoS with Virtual Channels Abstraction

Because speeds between the LAN and the WAN differ by orders of magnitude, no amount of compression or acceleration will solve all the problems. This dramatic discontinuity in bandwidth means that contention for WAN resource needs to be addressed with an effective and realistic QoS and bandwidth allocation model that enforces practical business priorities.

Makani provides custom QoS templates based on business priorities to simplify QoS configuration. This approach strikes the needed balance between performing QoS in the device — and keeps implementation simple.



Business critical traffic are prioritized with Virtual Channels

Makani implements network level QoS with a novel resource abstraction called **Virtuals Channels™**. Upto six Virtuals Channels™ can be dynamically instantiated: Customized QoS policy templates ensures that interactive and Internet-critical control traffic are prioritized first using high priority Virtual Channel. Voice and other real-time apps are similarly prioritized while ensuring that Web and business-critical enterprise applications get the major share of the link bandwidth (whenever they need it) even during periods of excessive app or resource contention. Finally, email (e.g., IMAP, SMTP) and bandwidth-hogging P2P applications get the remainder but never starve; per-user and app-specific rate control ensures the implementation of cost-effective and consistent QoS management policy. And by quickly looking inside the payload at the network level, Makani Platform can differentiate and prioritize one enterprise app traffic (e.g., Citrix) over another (e.g., SAP).

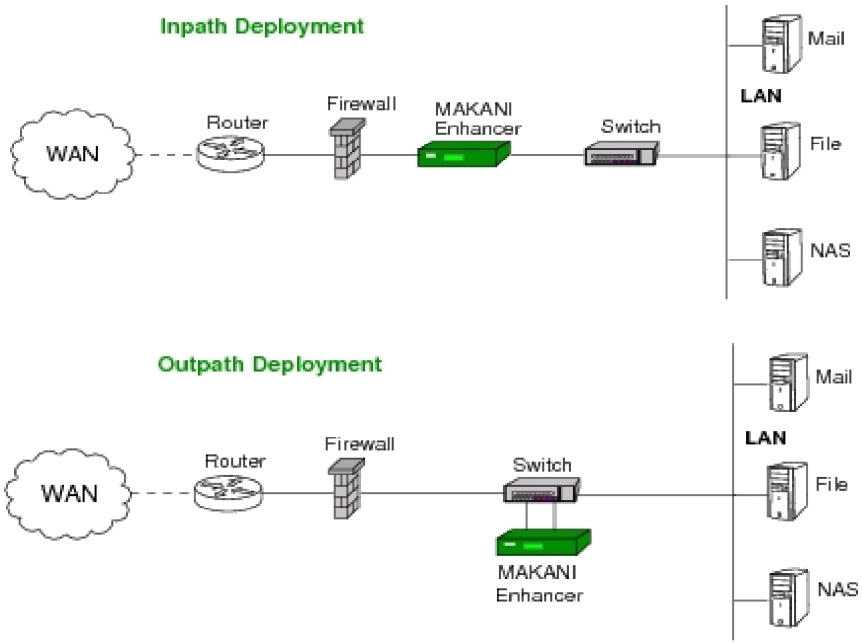
Makani Networks has designed the QoS feature such that ToS/DiffServ settings can be mapped to other network devices, tunneled traffic is still identifiable by application, and MPLS CoS information can be communicated to the edge devices in service provider networks without permanently overwriting anything in the original packet.

The “dual-sided” deployment allows Makani platforms, for example, to automatically map traffic according to the QoS template assigned to that destination device. The dynamic knowledge also enables IT to adopt the appropriate QoS policies. While the dual-sided approach provides for the greatest link understanding and dynamic behavior, the platforms also support “one-sided” deployments of QoS as well, to enable a consistent QoS policy across the distributed enterprise. Insight into the traffic type is essential for applying QoS appropriately.

Bottom Line: *Makani platforms provide the adaptive and dynamic QoS functionality enterprises need, without the complexity typically associated with defining granular bandwidth control.*

Transparent Deployment

The Makani platform is designed to not only provide up to a 5X-100X optimization and acceleration of data, but also to provide a fully fault-tolerant solution with no single point of failure. Makani appliances can be deployed with no changes to your servers, routers, applications, or user desktops. Makani appliances can accelerate data without interfering with your basic network infrastructure.



Makani appliances are transparently deployed in the network

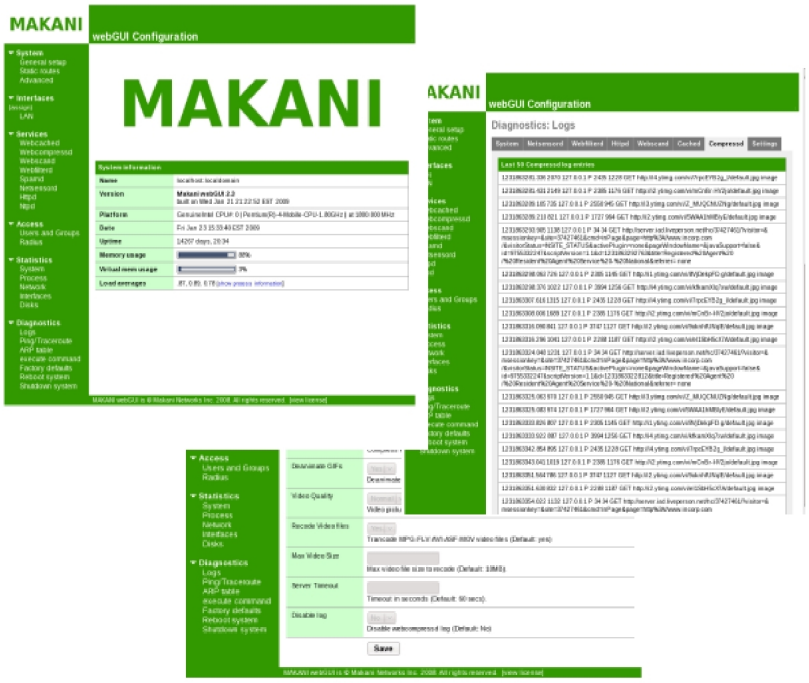
For network placement, a WAN optimization equipment can be deployed either on the network between a LAN switch and WAN router, or attached to a switch and router in a one-armed fashion. The Makani platforms support both these modes, with both InPath Mode and OutPath Mode options. A basic inline configuration is a common feature among WAN optimizers, but Makani devices are unique in their awareness of 802.1Q and their ability to compress traffic within the full 4095 number of supported VLANs. The platforms can optionally preserve the VLAN tags as packets are transported to other destinations through the tunnel.

The Makani platforms include a number of redundancy features. The devices support an active *fail-to-wire* mechanism so that in case of a device failure, all traffic will pass through the box at wire speed untouched. For additional levels of redundancy, Makani platforms support dual-active redundancy with no need for extra configuration of surrounding network devices, as well as an n+1 backup mechanism. The platforms also work with routers configured with redundancy protocols, and the devices can load-balance tunnel traffic to redundant WAN routers or load-balance to redundant destination Makani devices.

Bottom Line: *Makani Networks platforms provide the deployment flexibility needed for IT to meet the varying configuration and transport needs of different locations of the distributed enterprise.*

Ease of Use

A number of factors determine a device's usability—an intuitive interface, automated configuration and deployment capabilities, and synchronized communications among platforms are a few of the necessary elements.



Makani offers intuitive easy-to-use webGUI

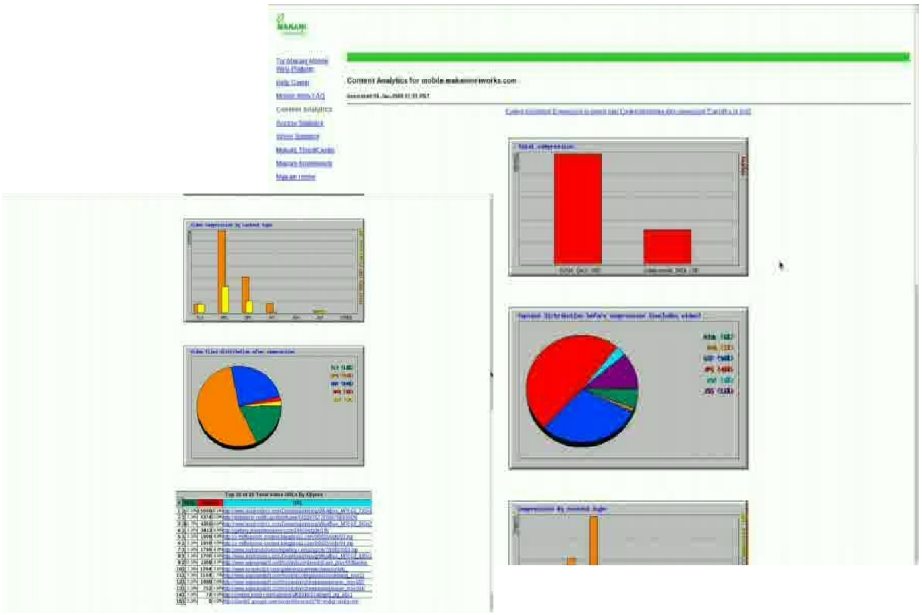
The Makani platforms are easy to use and manage, offering GUI-based views that allow IT to manage the devices individually or as a collection. Branch-office staff needs only to plug in the device and connect it to the network. Straight out of the box, the device will automatically procure a network address, locate the centralized management software (CMS) via the domain name service (DNS), request a configuration, download it, and begin operation. The easy deployment to branch offices produces a significant savings in staff time and money and enables rapid, pervasive deployment.

After a Makani device is up and running, it connects to the server to learn about other remote devices and how they're configured — for example, which devices are hubs and spokes; whether key compression techniques are enabled; whether security is enabled; and whether a device is sending out traffic over WAN links and other optimization. This information is essential to the synchronized communications amongst the Makani platforms. These communications provide distributed stateful intelligence about the network state and enable devices to act on changes such as link loss or increased congestion on a path. These automated synchronizations and communications dramatically simplify both setup and ongoing operations of the platforms.

Bottom Line: *An intuitive web GUI, significant automation capabilities, and synchronized communications among Makani platforms result in a very easy-to-use product set.*

Visibility with Makani Analytics

Makani Analytics offers web-based visibility like no other: compression statistics, detailed traffic statistics, cache performance statistics, cache hit/miss statistics, access statistics, data usage statistics, as well as application-specific compression analysis.



Makani offers comprehensive statistics and visibility

Makani Analytics performs in-depth analysis of logs: compression engine, cache engine and pattern storage. Makani offers the option to view information per device, and they can gain insight into such aspects as packet size distribution, error rates, throughput statistics, and TCP and application acceleration data.

Complementing the Makani Analytics software is the CMS software, which allows to configure and manage multiple Makani platforms from one central location. The CMS software provides a unified view into the systems' capabilities throughout the distributed enterprise. Makani offers metrics about compression performance, application acceleration, WAN utilization, and QoS and bandwidth allocation. The CMS software provides information about what traffic is traversing the WAN, which applications are consuming most of the valuable WAN capacity, and which traffic is being impacted by the application of QoS. Makani can help schedule system upgrades, apply new configurations, update QoS policies, and automate license management.

Bottom Line: *Makani platforms provide comprehensive insight into WAN and LAN traffic patterns that's easy for IT to understand and quickly enables policy adjustments that maximize the acceleration capabilities of network devices.*

Scalability

WAN optimization must scale from small branch offices to regional deployments to centralized hub locations. It must support a breadth of network traffic, a number of remote locations from a single-hub, high throughput of any single WAN optimizer, and the ability to support a worldwide implementation and deployment.

The Makani platforms meet these demands, easily scaling to support high compressed output speeds and thousands of connections per device to other application acceleration platforms. In addition to a high tunnel count, application acceleration platforms must enable tunnel configurations that support large, hierarchical networks. The architecture should provide automatic tunnel aggregation to support these complex topologies as networks increase in size. Makani platforms provides exactly that capability, enabling any-to-any communications between any two sites without requiring a full mesh setup of tunnels linking the sites. Makani offers the option to view multiple parameters at the same time, such as application, destination, and flow direction. Seeing this information tied together, it becomes easy to scale the WAN optimization to meet the broad needs of the enterprise.

Bottom Line: *Makani platforms provide a highly scalable product set and software suite that meet the wide range of application, bandwidth, and monitoring capabilities demanded in distributed enterprises.*

MAKANI networks

Makani offers high-performance, easy-to-use and technically innovative solutions for next-generation wide-area networked data services. Makani Enhancers™ are deployed for wide-area data acceleration and optimization. Makani Mobilizer™ appliances are deployed in the customer's network for blazing-speed data access over a wide-range of access networks. Founded in 2006, Makani is headquartered in San Francisco with regional offices all over the world.