

Project DRAC: Creating an applications-aware network

by Franco Travostino, Rob Keates, Tal Lavian, Inder Monga, and Bruce Schofield

Intelligent networking and the ability for applications to more effectively use all of the network's capability, rather than just the transport "pipe," have been elusive. Until now. Nortel has developed a proof-of-concept software capability – service-mediation "middleware" called the Dynamic Resource Allocation Controller (DRAC) – that runs on any Java platform and opens up the network to applications with proper credentials, making available all of the properties of a converged network, including service topology, time-of-day reservations, and interdomain connectivity options. With a more open network, applications can directly provision and invoke services, with no need for operator involvement or point-and-click sessions. In its first real-world demonstrations in large research networks, DRAC is showing it can improve user satisfaction while reducing network operations and investment costs.

Across a number of different fields – health care, manufacturing, and research and education, for example – users are demanding more and more network resources, such as bandwidth, quality of service, and security, in order to collaborate and share data around the globe. To meet these demands, the CIOs for these institutional, commercial, and research pools have employed several solutions, including supercomputing technologies, grid computing, and peak provisioning and manual provisioning of network resources. None of these methods, however, is optimal.

Supercomputing technology, for example, is expensive to scale and limited to those institutions and researchers that can afford it; high-performance grid computing, while it enables multiple users to share resources to boost processing power, is difficult to achieve due to the cost of interconnecting processors with low latency and high bandwidth; and statically and peak-provisioned network setups can result in over-provisioning of

network resources, which is expensive and results in CapEx and OpEx inefficiencies.

At the same time, operators must optimize their networks to meet diverse user requirements, which can range from single-user multi-Gbit/s data transfers (as with grid applications), to best-effort many-to-many kilobytes (such as e-mail). How can the network provide the cost/performance profile of lower-layer (e.g. optical) technologies while achieving the dynamic capabilities of higher layers? As well, how can the network adapt to the evolving applications?

Manual provisioning of network resources has also been known to present challenges. For example, processing their massive data files requires researchers to first contact a network administrator to set up and provision the appropriate network resources – typically a manual, error-prone task accomplished through a point-and-click session operated by the network administrator, which can lead to delays and potential failures.

Moreover, as data travels through the end-to-end network and across different networks, it typically encounters different types of network technologies – from packet, circuit, wireless, and wireline to various access environments – each with its own separate topologies, protocols, and features, again leading to missed opportunities or high CapEx/OpEx costs.

Dynamic Resource Allocation Controller

To address these challenges, Nortel has developed a proof-of-concept capability, called Dynamic Resource Allocation Controller (DRAC, pronounced d-rack).

Essentially, DRAC acts as an agent of the various applications, brokering and configuring on an end-to-end basis all the necessary pieces of the network, regardless of the type of network – circuit or packet, wireless or wireline. DRAC enables applications to control their share of network resources, yet without requiring them to interface directly with a wide range of diverse and constantly evolving network protocols, features, and devices. Put another way, DRAC lays the tracks ahead of the train, adjusts the network resources that an application needs, and steers the data through the network – and it does this either dynamically in real time or on a time reservation basis.

DRAC is implemented as software that is designed to be portable to any Java platform. This middleware sits between applications and the network (whether management

planes, control planes, or individual network elements) and provides applications with an abstracted view of the underlying network (Figure 1). The DRAC southbound interface features a framework for the instantiation of multiple “drivers,” corresponding to the different signaling techniques encountered in legacy networks (Figure 2).

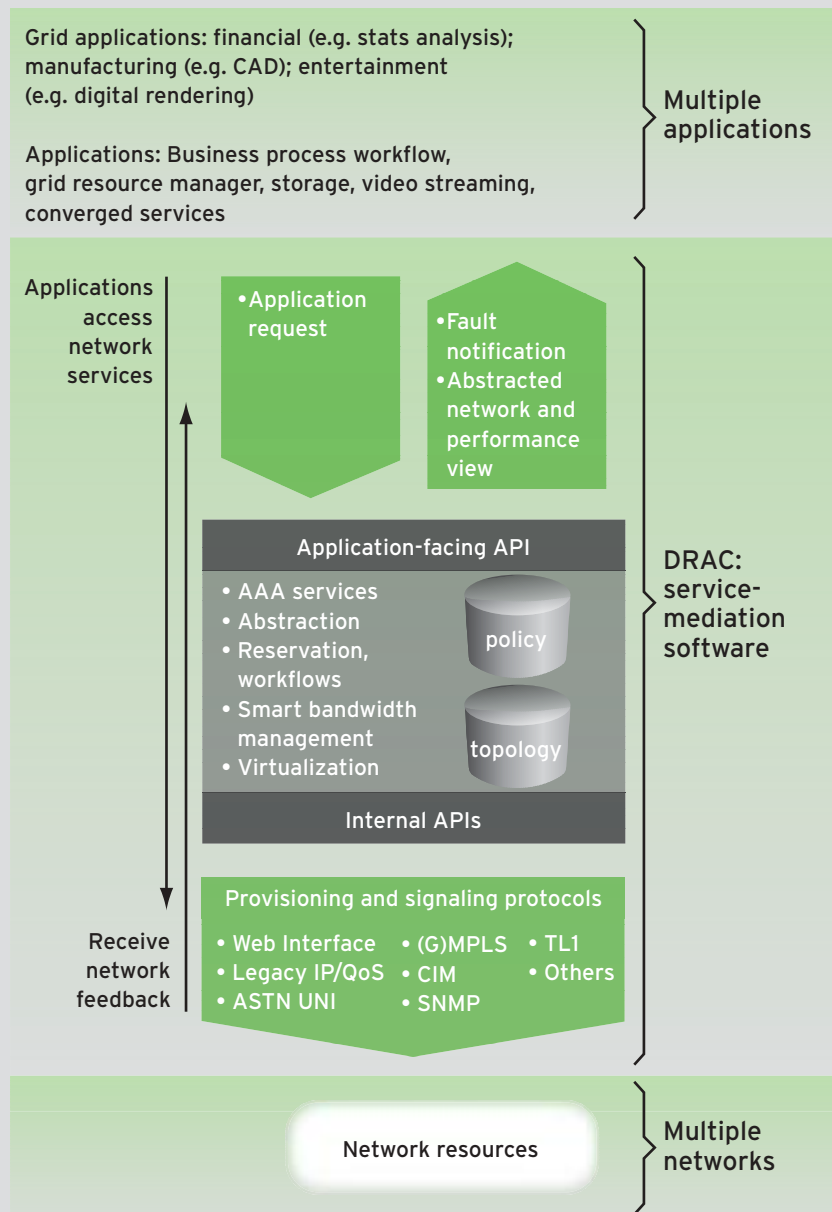
Three degrees of coupling

With the DRAC concept, Nortel envisions three degrees of coupling between applications and networks.

- *First degree:* In hybrid optical and packet networks, such as SURFnet6 (discussed later in this article), DRAC provides “cut-through” capabilities across network layers by steering very large flows of packets or low-latency applications dynamically over Layer 1 instead of Layer 3. For example, instead of dedicating routing resources to multi-Gigabit point-to-point file sharing applications or alternatively setting up a dedicated and costly high-bandwidth optical connection, DRAC simply sets up and takes down “ephemeral” optical circuits as they are needed, minute-by-minute, hour-by-hour. By bypassing the routing layer for this type of traffic, DRAC enables a higher-performance network experience for both routed and bypassed traffic and reduces the total number of routers required in the network. In fact, in one real-world design, DRAC reduced the number of required routers from 20 to 2. The same thesis can be applied to other environments featuring diverse technologies, such as between wireline and wireless.

- *Medium degree:* DRAC is capable of recognizing the network footprints of a given application (through deep packet inspection or direct signaling from the application, for example). DRAC makes sure that the network reacts appropriately to an application’s behavior. For

Figure 1. DRAC core framework



The DRAC core framework includes AAA (authentication, authorization, accounting) services, policy engine, topology discovery engine, resource reservation services, workflow utilities, interdomain routing facilities, and smart bandwidth management fixtures. The interface to applications is bi-directional, enabling network performance and availability information to be abstracted upward toward the application. The DRAC provides applications

with the means to directly drive their share of network resources within a policy-defined envelope of flexibility. Network resources include bandwidth, quality of service (QoS), security, acceleration appliances, sensors, and more. As well, the DRAC strategy is to use existing standards and toolsets for interfaces, which greatly simplifies deployment in multivendor, multi-technology environments.

example, when a critical storage restore operation is initiated due to disaster recovery, DRAC ensures that the network dedicates a large fraction of its resources to expedite that operation.

- *High degree*: DRAC becomes privy to the overall “flight plan” of an application. For instance, DRAC learns how a particular workflow unfolds among peering instances of a distributed application. That way, DRAC can anticipate the network

requirements, evaluate what-if scenarios, and enact failure-recovery strategies that are cognizant of the workflow. These are the defining properties of what we call “workflow-engaged networks” (WENs). In all cases, DRAC enables much more efficient use of network resources, leading to operational and capital savings.

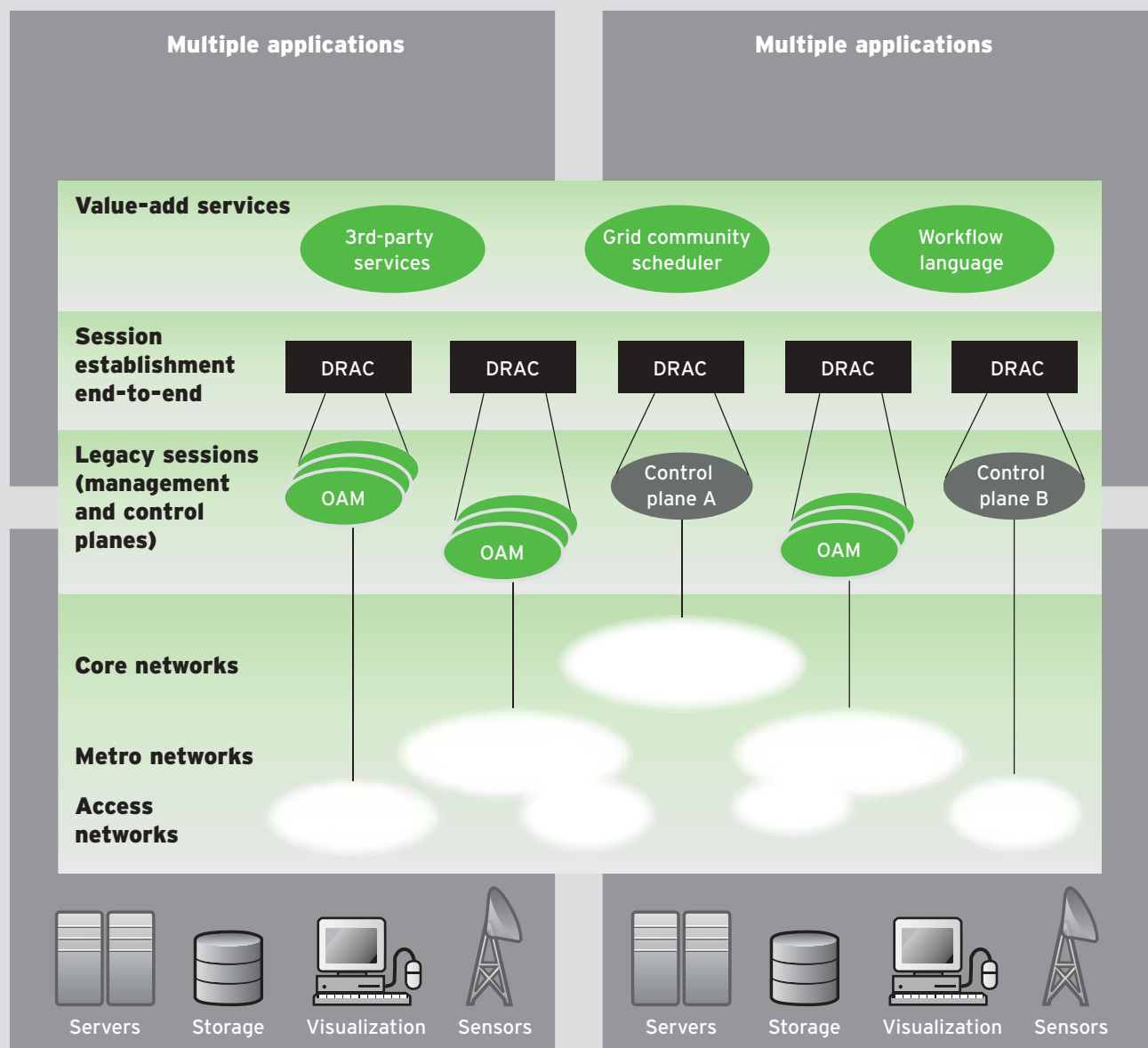
Application value

Currently, the DRAC value proposi-

tions have been validated within four vertical market segments:

- Hybrid optical and packet networks validate the DRAC cut-through capabilities by steering very large data flows across an ephemeral optical circuit, and allowing smaller flows that are more tolerant to latency and/or congestion loss to communicate via Layer 3.
- Within data centers, DRAC will help storage partners realize large bandwidth savings across metropoli-

Figure 2. DRAC middleware



DRAC sits between applications and the various networks that connect end systems, such as servers, storage,

visualization devices, and sensors.

What is SURFnet?

SURFnet is a national high-performance computer network in the Netherlands that connects more than 150 institutions in higher education and research to each other, as well as to other networks around the world.

Operated by a Netherlands-based company, SURFnet is among the leading research networks in the world, collaborating closely with national and international organizations and serving as an advanced test environment for investigating new technologies that will continually improve the reliability, security, and

speed of its network.

Among its many ongoing projects, SURFnet is responsible for the realization of the GigaPort Next-Generation Network – a project of the Dutch government, trade and industry, and educational and research institutions – that aims to strengthen the national knowledge infrastructure. Research on optical and IP networking and grids is a prominent part of the project. For more information, visit <http://www.surfnet.nl/>.

tan area networks (MANs) when operating replication, business continuance, and disaster recovery applications. During trials completed with some of Nortel's storage partners, the control and monitoring of storage and network management functions were consolidated into one unified "cockpit" versus two, to command and control these functions, with DRAC discovering the topology and composing a complete system view inclusive of the storage topology.

- Healthcare workflows (such as in radiology practices) are a natural fit for the DRAC's ambitions in WENs. Beyond the bandwidth savings seen in data center scenarios, the WEN can improve on dependability, while optimizing the expenses in network and storage setups. [For further detail, refer to Schofield's paper "Workflow Engaged Networks for Radiology in Metro Regions," presented at the 90th RSNA, Radiological Society of North America, Chicago, November 28, 2004. This is the study of a network (wireline, LAN+MAN) utilized for Filmless Radiology, with and without a DRAC framework.]

- Within grid computing communities, we are working to elevate the network to a primary grid-managed

resource, akin to CPU and storage resources. DRAC can tame the complexity and diversity of network elements to open the way for e-utilities.

Demonstrating the values

DRAC has demonstrated compelling values in a wide range of applications. Detailed studies by Nortel have shown large cost savings in MANs and wide area networks (WANs), providing an appealing alternative to the old approach of static, over-provisioned networks.

As well, DRAC is undergoing validation in real-world network deployments with high-performance computing networks. For instance, the Netherlands-based SURFnet is currently deploying DRAC at the heart of a hybrid optical and packet network, called SURFnet6, which is being realized in the context of the GigaPort Next-Generation Network project (see sidebar). (SURFnet 6 optimizes Layer 1 network resource utilization based upon end-user requirements.) In this implementation, applications driving multi-Gbit/s transfers bypass the packet layer and are steered directly onto wavelengths between end points across temporarily assigned optical links.

In addition to the SURFnet project,

Nortel recently demonstrated DRAC features at the Supercomputing 2004 conference in November 2004. This demonstration was done in cooperation with recognized research and education leaders, including SURFnet, Netherlight, the University of Amsterdam, Internet2, Canarie, iCAIR, and Starlight. Encouraged by the results of the DRAC preliminary results, Nortel is currently looking to a broader deployment market opportunity.

Franco Travostino *is leader of an Advanced Technology Team that is exploring applications-engaged networks and grid infrastructures. This team includes Tal Lavian, Inder Monga, and Bruce Schofield. Rob Keates is senior manager, optical networks marketing.*

Note: This article has been adapted from a Nortel Applications Brief (www.nortel.com/drac), published in November, 2004, and distributed at Supercomputing 2004, held in Pittsburgh, Pennsylvania.