MANAGING TECHNOLOGY. DRIVING RESULTS.

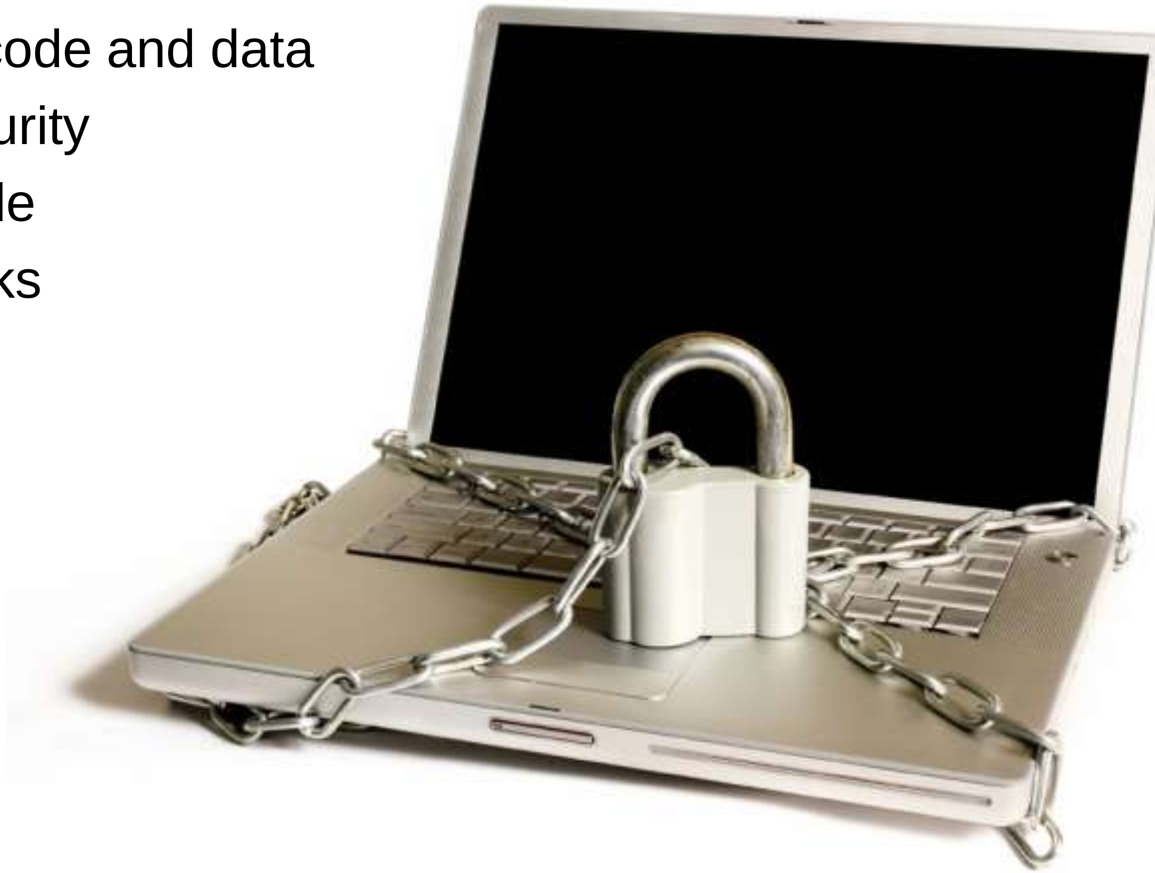
Pretty Good Row Level Security

Bob Lambert
Nic Morel

1419 West Main Street, Richmond, VA 23220
www.captechventures.com

Table of Contents

- Evolution of Data Security
- New Challenges
- Securing both code and data
- Row Level Security
- Generic example
- Adventure Works
  - Example 1
  - Example 2
- Conclusion



The evolution of data security is not over

- Complex architectures
  - 1970 – Democratization of the Mainframe
  - 1980 – 2 tier applications relying on Mainframe
  - 1990 – 3 tier applications with multiple databases (introduction of EAI middlewares)

- First IT generation
  - First IT professional with 100% of carrier in IT are retiring now

- New public / end users with new channels
  - Human to Human
  - Kiosk and Voice Response Unit to Humans, Corporate servers to others (APIs)
  - Internet to Humans
  - Phones, etc to Humans

New challenges are still coming

- Shared infrastructure
  - Mainframes to multiple users
  - Multi-tiers applications create Identity Management challenges

- Data accessed by Internet Users
  - First, public information to the public (ex: corp websites)
  - Private information to customers / patients (ex: MyUHC.com)
  - Private information to public (ex: mypace)

- Outsourced IT can create risks for corporations
  - Longer lifespan of applications
  - High turnover of IT professional

Securing code and data

- ❑ First, Security is at the application level
  - ■ Introduction of RACF and ACF2 limits access to screens
- ❑ Second, secured object oriented coding
  - ■ Security is at the object level
  - ■ Users and systems have access to objects
- ❑ Third, secured data repositories
  - ■ System IDs limit read / write to entire tables, even columns

Do we need more data Security?

Well what if…

- We could limit access at the data level?

□AND

- We could have a solution that leverages existing and simple database protocols?

□AND

- We did not need to add another complex layer of security that will require resources to administer?

□AND

- We could use a technique that will be impermeable to IT Staff changes and won’t slow down upgrade projects?

What is Row Level Security?

- ❑ One definition
  - A method of providing another level of access security in a database by exploiting existing business data

- ❑ Row Level Security is not new.
  - Oracle provides RLS as a feature (Labels Security)
  - PeopleSoft has embedded features for RLS
  - Business Objects has numerous white papers

- ❑ This presentation explores a generic way of implementing RLS by
  - Restricting user access to data based on data in the row,
  - Keeping the content of business tables unchanged
  - Not affecting application or presentation developers regardless of how users access the data.

Alternative Row Level Security Solutions

Available approaches don’t meet our requirements. For example:

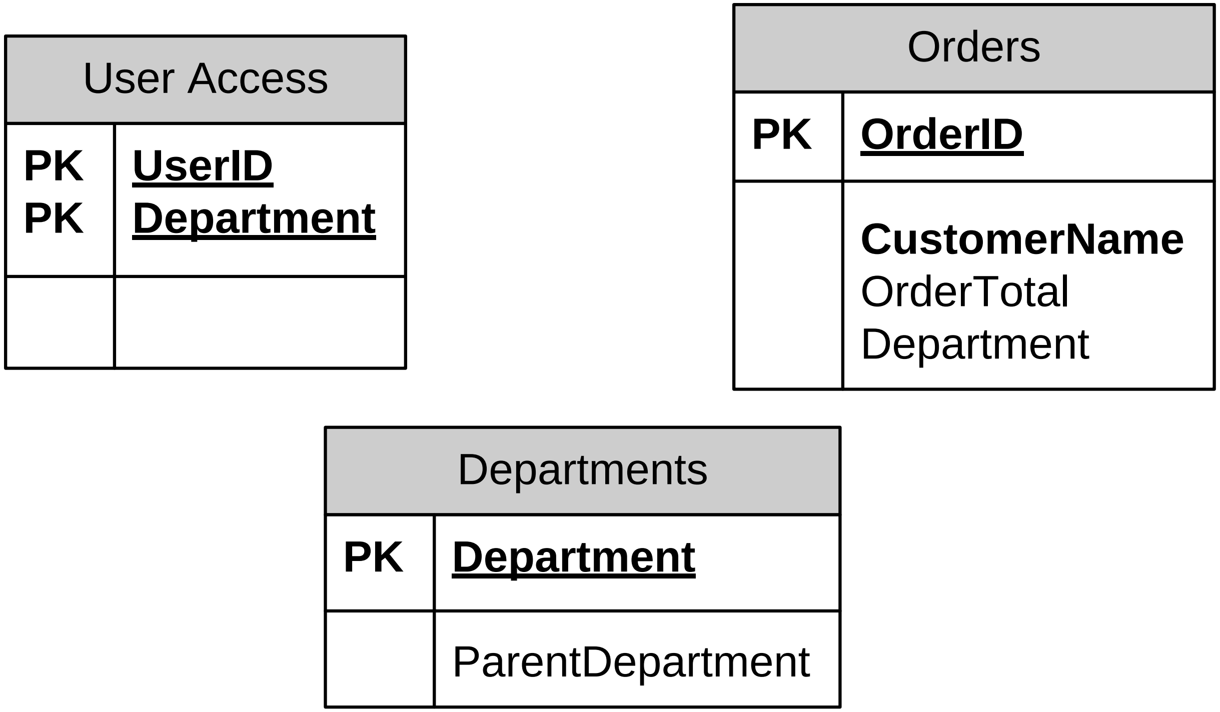
- “Implementing Row Level Security in SQL Server Databases” by Narayana Vyas Kondreddii recommends addition of user id as a column on secure tables.
    - http://vyaskn.tripod.com/row_level_security_in_sql_server_databases.htm
- Rask, Rubin, and Neumann offer on the Microsoft Technet site a solution based on defining views that again requires base table modifications.
    - http://www.microsoft.com/technet/prodtechnol/sql/2005/multisec.mspx#E3MAC
- Kemal Erdogan presents a promising solution based on lookup tables. That doesn’t require base table changes but leaves the tables unsecured in the case or direct user database access.
    - http://www.codeproject.com/KB/database/AFCAS.aspx

Provisos and Quid Pro Quos

- SQL Server database (MS SQL Server 2000, 2005, or 2008)
- An attribute exists in common to all tables to be secured that makes sense as a determinant of who sees what data (in the example, department id)
- Application calls passed to the database are secured by individual user id, not by a single admin user id
- We'll show only Select security; the concept can be extended to cover Update and Insert statements
- The solution presented is not optimized
  - Performance in your environment will depend on its unique characteristics

Generic Example: SQL Server Table Definition (Slide 1 of 3)

- ❑ Overall Approach: add a cross reference table that links userids to the security attributes.



User Access	
PK **PK**	**<u>UserID</u>** **<u>Department</u>**

Orders	
PK	**<u>OrderID</u>**
	CustomerName OrderTotal Department

Departments	
PK	**<u>Department</u>**
	ParentDepartment

Generic Example: SQL Server Table Definition (Slide 2 of 3)

- Creating an RLS function step 1: Protect data with Table Valued Functions requiring

```
CREATE FUNCTION [adhoc].[u_GetOrderSummary] ()
RETURNS TABLE
AS
RETURN
(
   SELECT OrderCount, Receipts
           FROM dbo.GetOrderSummary(Current_User)
)
```

- The problem: the user could key any user’s id as a parameter to circumvent security

Generic Example: SQL Server Table Definition (Slide 3 of 3)

- A solution: Prevent user logins to the application database, but enable them to a separate database that contains table valued functions that call those requiring user ids as parameters, as follows:

```
CREATE FUNCTION [adhoc].[u_GetOrderSummary] ()
RETURNS TABLE
AS
RETURN
(
   SELECT OrderCount, Receipts
           FROM dbo.GetOrderSummary(Current_User)
)
```

RLS in a reasonably complex database: The Adventure Works Examples

- The database Adventure Works is shipped in every MS SQL server application as an example.
  - It represents a company called Adventure Works
  - Business processes are all modeled and include (and is not limited to):
    - Sales
    - Production
    - HR
    - Ordering

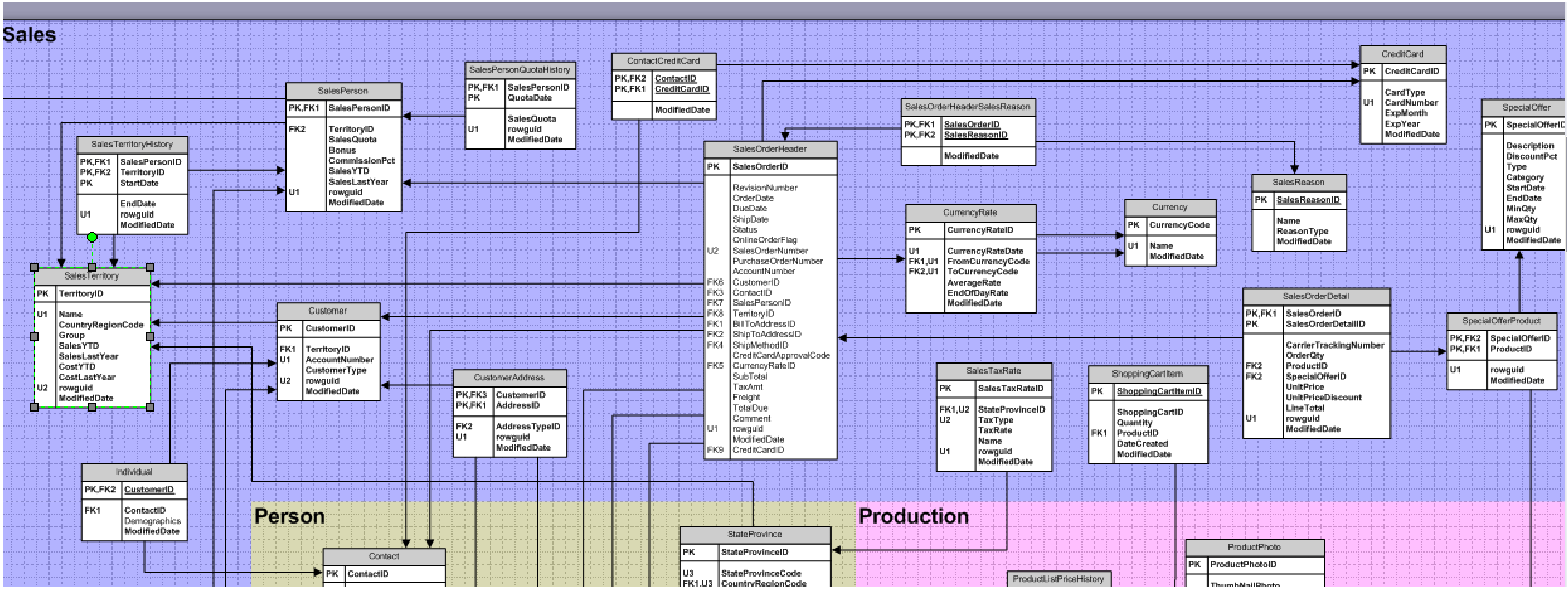
- Two examples of Adventure Works RLS have been developed:
  - A sales person can only sell in his/her territory
  - HR professionals can only see data for employees in their assigned departments

A sales person can only sell in his/her territory (Slide 1 of 4): The Problem and Strategy

- ❑ What we are trying to solve:
  - Right now, all Sales resources perform a sale in every territory.
  - The new rule is that one can only sale in its own territory

- ❑ What we are going to do:
  - We create a function that links user ID to the Territory
  - We create a view to prevent the user from inserting a different user ID than his

A sales person can only sell in his/her territory (Slide 2 of 4): The Data Model



	SalesPerson
PK,FK1	SalesPersonID
FK2 U1	TerritoryID SalesQuota Bonus CommissionPct SalesYTD SalesLastYear rowguid ModifiedDate

	SalesPersonQuotaHistory
PK,FK1 PK	SalesPersonID QuotaDate
 U1	SalesQuota rowguid ModifiedDate

	SalesTerritoryHistory
PK,FK1 PK,FK2 PK	SalesPersonID TerritoryID StartDate
 U1	EndDate rowguid ModifiedDate

	SalesTerritory
PK	TerritoryID
U1 U2	Name CountryRegionCode Group SalesYTD SalesLastYear CostYTD CostLastYear rowguid ModifiedDate

	Customer
PK	CustomerID
FK1 U1 U2	TerritoryID AccountNumber CustomerType rowguid ModifiedDate

	CustomerAddress
PK,FK3 PK,FK1	CustomerID AddressID
FK2 U1	AddressTypeID rowguid ModifiedDate

	Individual
PK,FK2	CustomerID
FK1	ContactID Demographics ModifiedDate

	Contact
PK	ContactID

	ContactCreditCard
PK,FK2 PK,FK1	ContactID CreditCardID
	ModifiedDate

	SalesOrderHeader
PK	SalesOrderID
      U2 FK6 FK3 FK7 FK8 FK1 FK2 FK4 FK5 U1 FK9	RevisionNumber OrderDate DueDate ShipDate Status OnlineOrderFlag SalesOrderNumber PurchaseOrderNumber AccountNumber CustomerID ContactID SalesPersonID TerritoryID BillToAddressID ShipToAddressID ShipMethodID CreditCardApprovalCode CurrencyRateID SubTotal TaxAmt Freight TotalDue Comment rowguid ModifiedDate CreditCardID

	SalesOrderHeaderSalesReason
PK,FK1 PK,FK2	SalesOrderID SalesReasonID
	ModifiedDate

	CurrencyRate
PK	CurrencyRateID
U1 FK1,U1 FK2,U1	CurrencyRateDate FromCurrencyCode ToCurrencyCode AverageRate EndOfDayRate ModifiedDate

	Currency
PK	CurrencyCode
U1	Name ModifiedDate

	SalesReason
PK	SalesReasonID
	Name ReasonType ModifiedDate

	CreditCard
PK	CreditCardID
U1	CardType CardNumber ExpMonth ExpYear ModifiedDate

	SpecialOffer
PK	SpecialOfferID
        U1	Description DiscountPct Type Category StartDate EndDate MinQty MaxQty rowguid ModifiedDate

	SalesOrderDetail
PK,FK1 PK	SalesOrderID SalesOrderDetailID
  FK2 FK2 U1	CarrierTrackingNumber OrderQty ProductID SpecialOfferID UnitPrice UnitPriceDiscount LineTotal rowguid ModifiedDate

	SpecialOfferProduct
PK,FK2 PK,FK1	SpecialOfferID ProductID
U1	rowguid ModifiedDate

	SalesTaxRate
PK	SalesTaxRateID
FK1,U2 U2 U1	StateProvinceID TaxType TaxRate Name rowguid ModifiedDate

	ShoppingCartItem
PK	ShoppingCartItemID
  FK1	ShoppingCartID Quantity ProductID DateCreated ModifiedDate

	StateProvince
PK	StateProvinceID
U3 FK1,U3	StateProvinceCode CountryRegionCode

	ProductPhoto
PK	ProductPhotoID
	ThumbNailPhoto

ProductListPriceHistory

A sales person can only sell in his/her territory (Slide 3 of 4) The Function

```
-- based on Sales.vSalesPersonSalesByFiscalYears

TABLE VALUED FUNCTION
CREATE FUNCTION [Security].[ufnGetSalesTotals]
(
       @UserId VARCHAR(20)
)
RETURNS TABLE
AS
RETURN
(
SELECT
       pvt.[SalesPersonID]
       ,pvt.[FullName]
       ,pvt.[Title]
       ,pvt.[SalesTerritory]
       ,pvt.[2002]
       ,pvt.[2003]
       ,pvt.[2004]
       FROM (SELECT
               soh.[SalesPersonID]
               ,c.[FirstName]
                              + ' '
                              + COALESCE(c.[MiddleName],
       '')
                              + ' '
                              + c.[LastName] AS
       [FullName]
               ,e.[Title]
               ,st.[Name] AS [SalesTerritory]
               ,soh.[SubTotal]
               ,YEAR(DATEADD(m, 6, soh.[OrderDate]))
                              AS [FiscalYear]
               FROM [Sales].[SalesPerson] sp
                 INNER JOIN [Sales].[SalesOrderHeader] soh
                 ON sp.[SalesPersonID] = soh.[SalesPersonID]
                                 INNER JOIN [Sales].[SalesTerritory] st
                                 ON sp.[TerritoryID] = st.[TerritoryID]
                                 INNER JOIN Security.SalesAccess sa
                                 ON sa.TerritoryID = st.[TerritoryID]
                                 AND sa.UserId = @UserID
                                 INNER JOIN [HumanResources].[Employee] e
                                 ON soh.[SalesPersonID] = e.[EmployeeID]
                                 INNER JOIN [Person].[Contact] c
                                 ON e.[ContactID] = c.ContactID
                 ) AS soh
PIVOT
(

                 SUM([SubTotal])
                 FOR [FiscalYear]
                 IN ([2002], [2003], [2004])


) AS pvt
)
```

A sales person can only sell in his/her territory (Slide 4 of 4) Securing with a view

- The Secure View

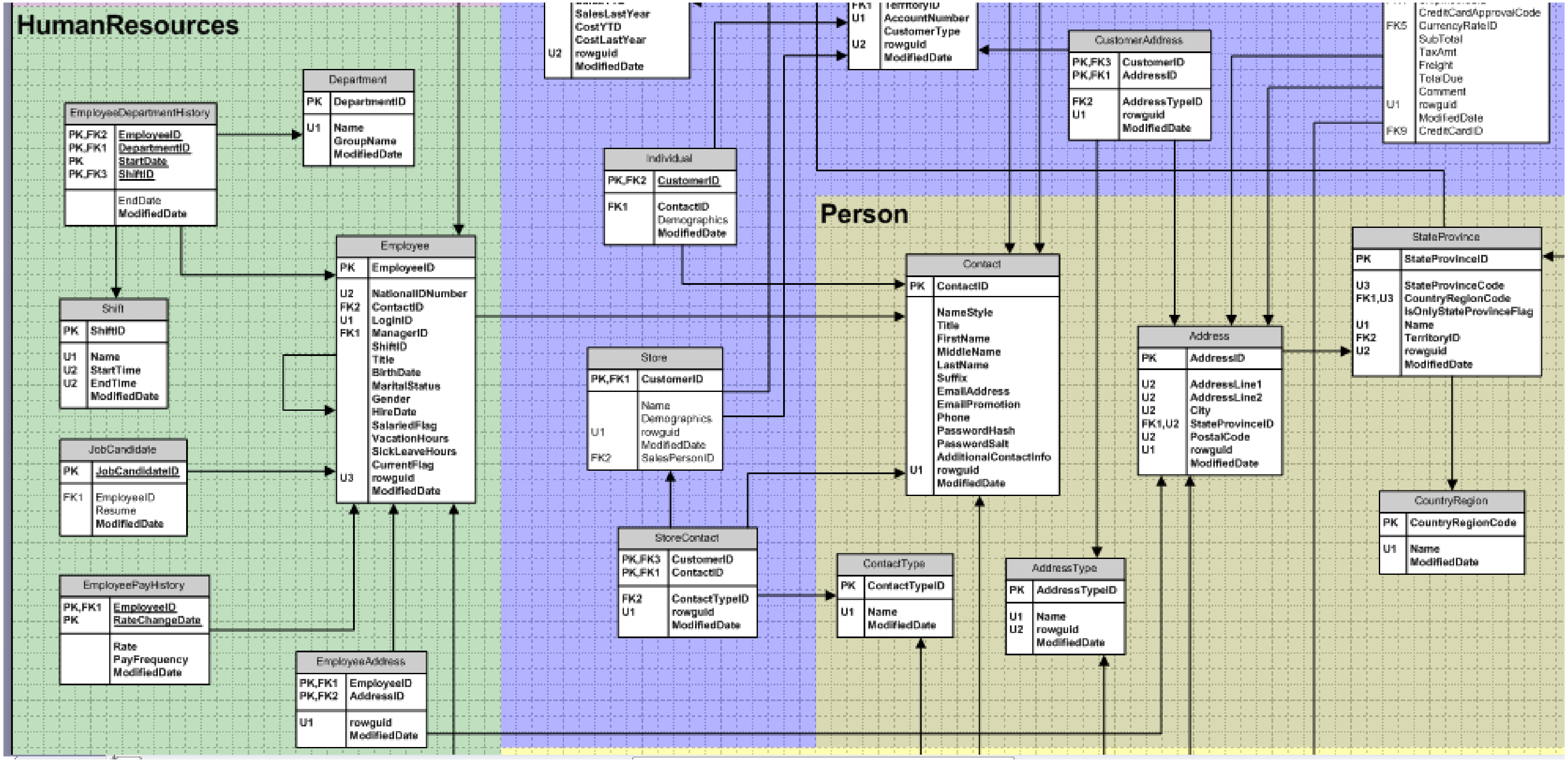
```
CREATE VIEW [Security].[vsSalesTotals]
AS
SELECT
      [SalesPersonID]
     ,[FullName]
     ,[Title]
     ,[SalesTerritory]
     ,[2002]
     ,[2003]
     ,[2004]
FROM Security.ufnGetSalesTotals(USER)
```

HR professionals can only see data for employees in their assigned departments (Slide 1 of 4): The Problem and Strategy

- ❑ What we are trying to solve:
  - Right now, all HR employees have access to all employee data.
  - We want to limit them and assigned them to specific departments

- ❑ What we are going to do:
  - We create a function that links user ID to the Territory
  - We create a view to prevent the user from inserting a different user ID than his

HR professionals can only see data for employees in their assigned departments (Slide 2 of 4): The Data Model



HR professionals can only see data for employees in their assigned departments (Slide 3 of 4) The Function

```
-- based on HumanResources.vEmployee

CREATE FUNCTION [Security].[ufnGetEmployeeData]
(
      @UserId VARCHAR(20)
)
RETURNS TABLE
AS
RETURN
(
      SELECT
                e.[EmployeeID]
                ,c.[Title]
                ,c.[FirstName]
                ,c.[MiddleName]
                ,c.[LastName]
                ,c.[Suffix]
                ,e.[Title] AS [JobTitle]
                ,edh.DepartmentID
                ,dpt.Name AS [DepartmentName]
                ,shr.UserID
                ,c.[Phone]
                ,c.[EmailAddress]
                ,c.[EmailPromotion]
                ,a.[AddressLine1]
                ,a.[AddressLine2]
                ,a.[City]
                ,sp.[Name] AS [StateProvinceName]
                ,a.[PostalCode]
                ,cr.[Name] AS [CountryRegionName]
                ,c.[AdditionalContactInfo]
      FROM [HumanResources].[Employee] e
                INNER JOIN [Person].[Contact] c
                ON c.[ContactID] = e.[ContactID]
                INNER JOIN [HumanResources].[EmployeeAddress] ea
                ON e.[EmployeeID] = ea.[EmployeeID]
                INNER JOIN [Person].[Address] a
                ON ea.[AddressID] = a.[AddressID]
                INNER JOIN [Person].[StateProvince] sp
                ON sp.[StateProvinceID] = a.[StateProvinceID]
                INNER JOIN [Person].[CountryRegion] cr
                ON cr.[CountryRegionCode]
                        = sp.[CountryRegionCode]
                INNER JOIN
      HumanResources.EmployeeDepartmentHistory edh
                ON edh.EmployeeID = e.EmployeeID
                AND edh.EndDate is null
                INNER JOIN Security.HRAccess shr
                ON shr.DepartmentID = edh.DepartmentID
                AND shr.UserID = @UserID
                INNER JOIN HumanResources.Department dpt
                ON dpt.DepartmentID = edh.DepartmentID
```

HR professionals can only see data for employees in their assigned departments (Slide 4 of 4): Securing with a view

```
CREATE VIEW [Security].[vsEmployee]
AS
SELECT
         [EmployeeID]         ,[Title]
        ,[FirstName]          ,[MiddleName]
        ,[LastName]           ,[Suffix]
        ,[JobTitle]           ,DepartmentID
        ,[DepartmentName]     ,UserID
        ,[Phone]              ,[EmailAddress]
        ,[EmailPromotion]     ,[AddressLine1]
        ,[AddressLine2]       ,[City]
        ,[StateProvinceName]  ,[PostalCode]
        ,[CountryRegionName]  ,[AdditionalContactInfo]
FROM Security.ufnGetEmployeeData(USER)
```

Summary

- RLS allowed us to add security controls and implement business rules on existing databases
  - The overall structure of the database stays unchanged
  - Cost of developments are low
  - Functions can be reused for future developments

- Other possible enhancements
  - Add a audit functionality: create a log of who tried to access which data and at what time (Sarbox, HIPAA and regulatory requirements)
  - Link to an LDAP like Active Directory for permanent business or security requirements