MASARYKOVA UNIVERZITA

PV213 Enterprise Information Systems in Practice

06 - Architecture of the EIS in the standard environment

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Tento projekt je spolufinancován Evropským sociálním fondem a státním rozpočtem České republiky.

INVESTICE DO ROZVOJE VZDĚLÁVÁNÍ

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What is SW architecture?

The software architecture of a system is the set of structures needed to reason about the system, which comprise software elements, relations among them, and properties of both.

"Structure of structures"

Why we need SW architecture?

Why SW architecture is created?

- Increase product quality
  - Functional requirements
  - Non-functional requirements
- Understand product structure
- Speedup development time
- Minimize maintenance costs

Architect in history

The ideal architect should be a person of letters, a mathematician, familiar with historical studies, a diligent student of philosophy, acquainted with music, not ignorant of medicine, learned in the responses of jurisconsults, familiar with astronomy and astronomical calculations.

—Vitruvius, circa 25 BC

Vitruvius was a Roman architect and the author of the *De architectura*.

Pont du Gard, France

SW Architect - role in the team

Key responsibilities

- Creating and **documenting** architecture
  - High level
  - Design decisions (especially non functional requirements)
  - Guidelines
- **Communication** between different stakeholders
  - Requirements with customer / analyst / business people
  - Planning with project manager
  - SW architecture / design with developers, testers
- **Supervising** project from technical point of view

We can differentiate: business architect, enterprise architect, solutions architect, application architect

Non-functional requirements

Product qualities which are often overseen but they are important part of the product.

- **Performance** – e.g. transactions per seconds
- **Scalability** – ability to "grow" with increasing load
- **Reliability** – ensures integrity and consistency
- **Availability** – e.g. in percentage (99,9%)
- **Security** – system and its data cannot be compromised
- **Maintainability** – ability to correct flaws without big impacts
- **Manageability** – monitor system health, change of configuration
- **Extensibility** – ability to add new functionality without big changes
- **Testability** – ability to test
- …

Architecture types – Monolithic (1-tier)

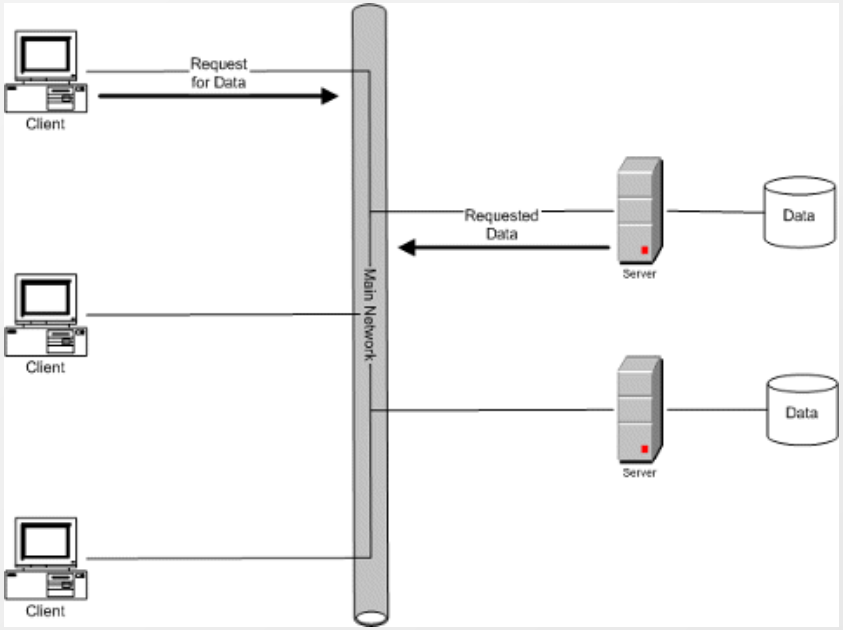
- First type in history (on mainframes)
- Everything in one monolithic application
  - User interface
  - Application (business) logic
  - Persistence logic (database)
- Simple
- Hard to fulfill some non-functional requirements
  - Non-scalable
  - Hard to extend
  - Hard to maintain
- Today valid only in very special cases - embedded SW with small resources (CPU power, memory, without network connectivity)

Architecture types - 2-tier I

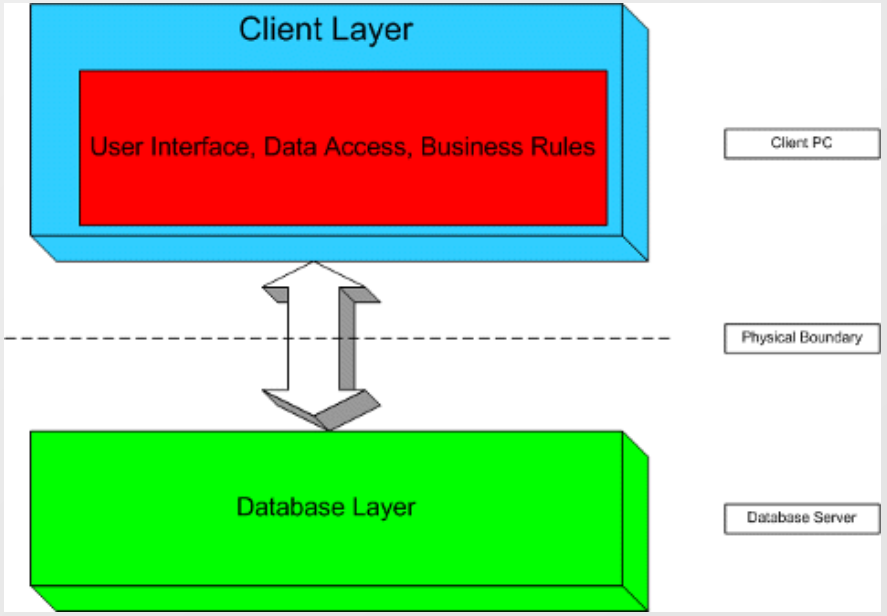
- Separation
  - First tier – User interface plus application logic
  - Second tier – Persistence (database)
- Also called client / server architecture (popular in 1980s)
- Allows to easily share data from different clients
- Still hard to fulfill some non-functional requirements
- Used mostly in desktop applications
  - Hard to change business logic (requires redeployment)
- Small modification for exceptional web applications
  - First tier – User interface
  - Second tier – Application logic and persistence
- Not recommended for new development

Architecture types - 2-tier II

Physical model



Logical model

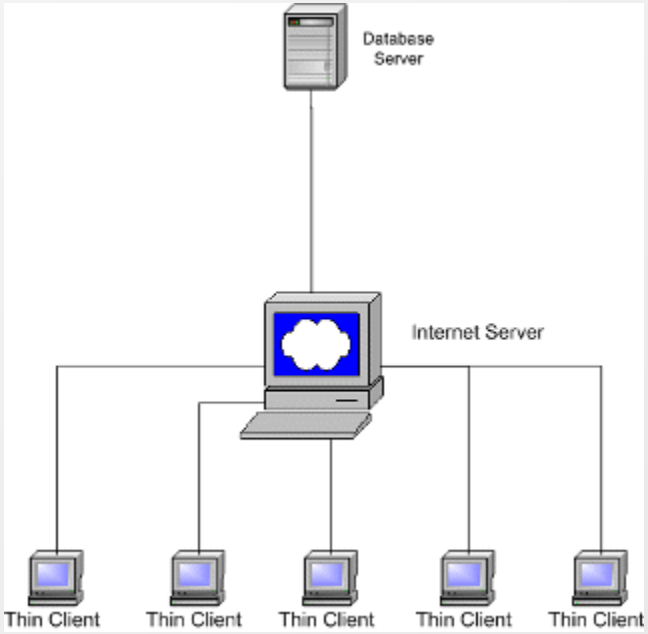


Architecture types – 3-tier (n-tier) I

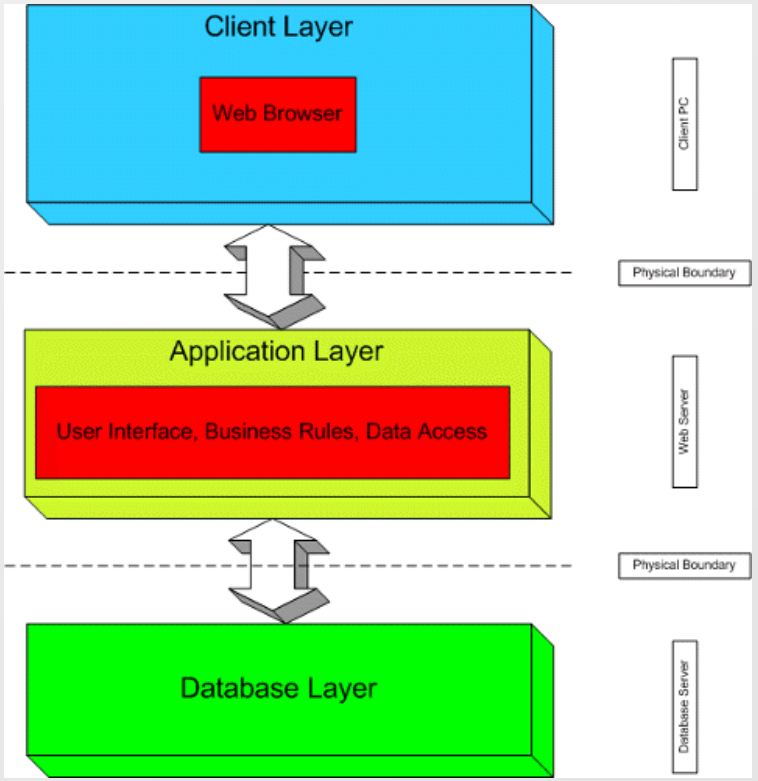
- Separation
  - First tier – User interface
  - Second tier – Application logic
  - Third tier – Persistence
- Separation allows to increase quality of the system
  - E.g. change of the business logic doesn't influence presentation tier (user interface)
- Valid for most of web applications
- Standard in designing systems today

Architecture types – 3-tier (n-tier) II

Physical model



Logical model

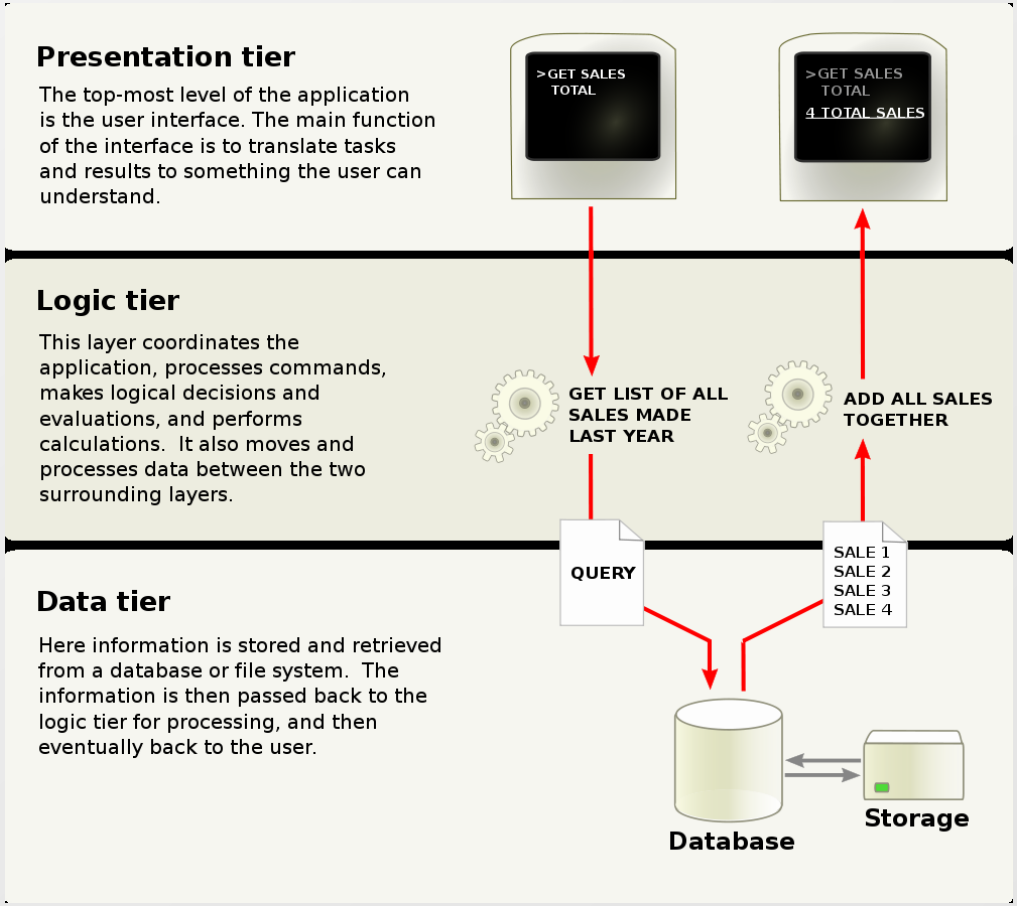


Architecture types – 3-tier (n-tier) III

Tiers represents machine boundaries

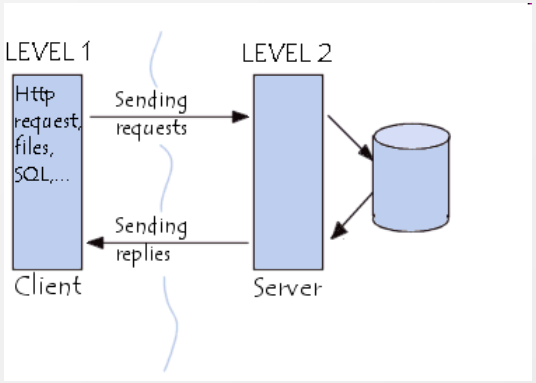
Much easier to scale

Changes are separated

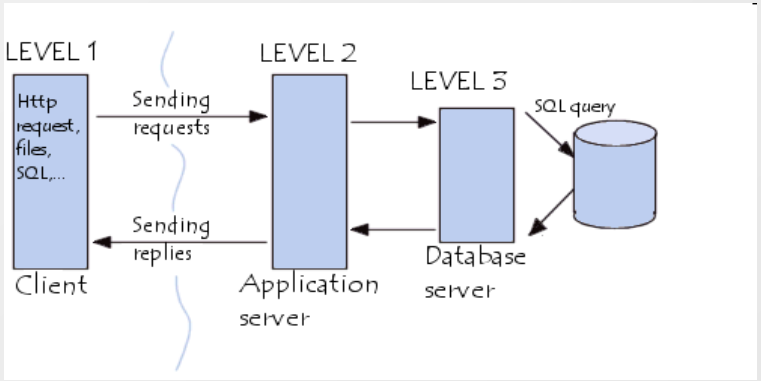


Architecture types - Comparison of 2,3 and n-tier

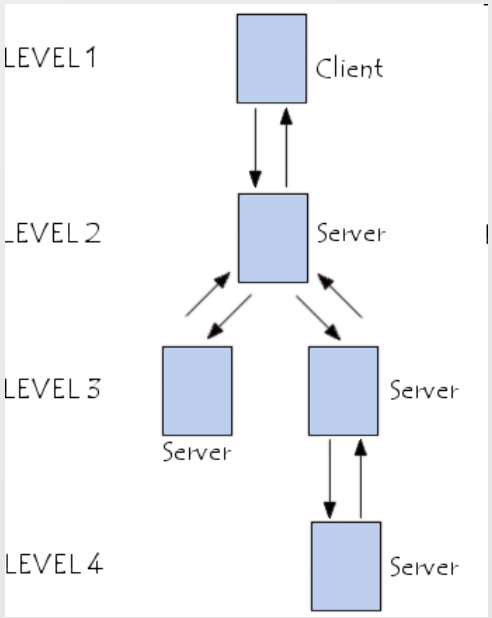
2-tier



3-tier

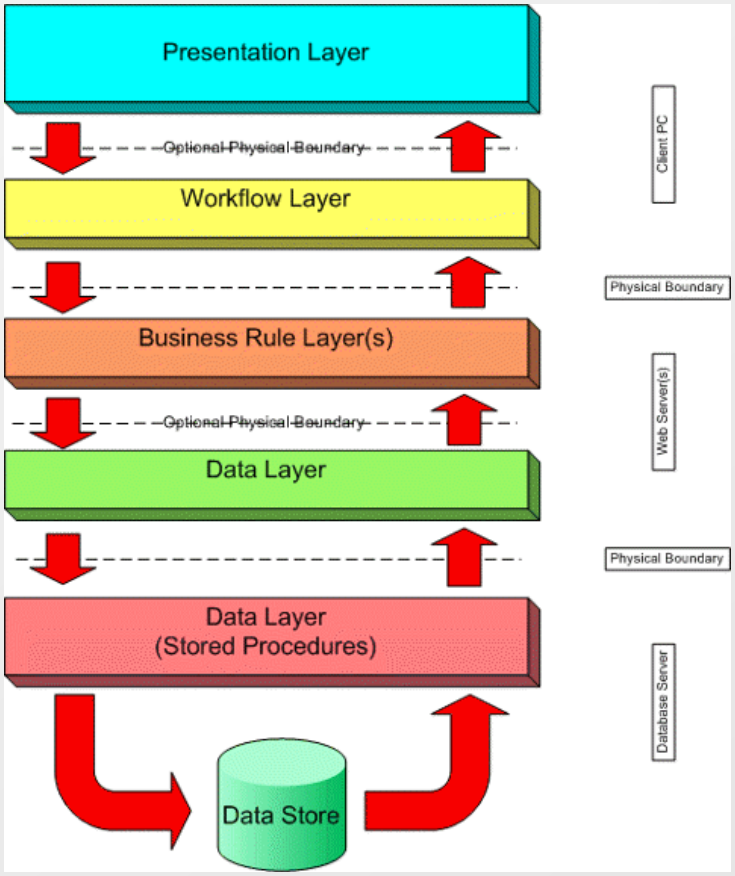


n-tier



Architecture types - Possible structuring in n-tier

Logical model



Thick and thin client

- **Thick client** provides rich functionality without server
  - Requires some installation on the client's device
  - Can run independently without servers
  - Can use all HW device provides (rich and fast GUI, external HW)
  - Migration to newer version (update) is harder

- **Thin client** delegates functionality to other devices (servers)
  - Don't require installation on the client's device
  - Cannot run independently without servers
  - Access to HW is limited
  - Migration to newer version (update) is easier
  - Requires some "specialized OS" (web browser, "player", etc.)
  - Servers are the bottleneck

In reality thick and thin clients overlap (browser plugins, zero installations, …).

Example - Reservation system (refresh)

Reservation system allows to

- Make reservations for pool equipments
- Cancel reservations
- Show calendar with reservations
- Import definition of equipments from external inventory system
- Send usage statistics to management reporting system

Example - Reservation system - Architectural thoughts I

You have to consider which architecture solves the best your functional and non-functional requirements with additional restrictions (constraints) to

- Given budget
- Expected timeframe
- Skills in your team
- Expected live time of the product
- Non-technical constraints (team motivation, overall atmosphere, …)
- …

You can try **negotiate** some (or all) constraints with project (or product) manager (business people, customer, …).

Live is not ideal but good **communication** with other people can simplify it!

Example - Reservation system - Architectural thoughts II

Possible questions we have to ask

- How users will use the Reservation system?
  - Is program installation on user's device required? Thick / thin client? What are prerequisites?
  - Which operating systems are required to support?
  - Which types of user's devices are required (e.g. mobile)?
- How data will be shared between users? Is sharing of data possible?
- How product will interact with external systems (inventory and reporting system)?
- How system will be maintained?
- How system will scale when amount of users grow?
- How possible new requirements will influence the system?
- …

Example - Reservation system - 1-tier architecture?

- Implies thick client
  - Installation of client required
  - Update of client can be complicated (distributed redeployment)
- Sharing of data complicated
  - Each user has its own copy of database
  - Needed to solve synchronization of databases (when number of users grow more data has to be transferred between clients)
- Some functional requirements are hard to implement – e.g. export to reporting system
  - Which client will do it? What if he is ill?
  - Another special application for export? How and who will start it?

- Result: Inadequate architecture for our purposes

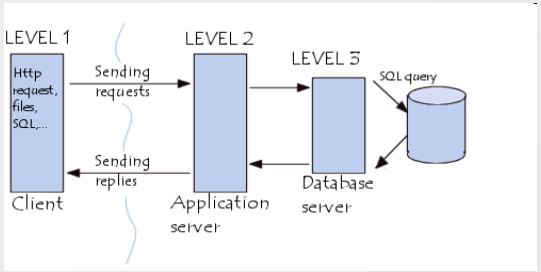
Example - Reservation system - 2-tier architecture I?

- Desktop application (thick client)
  - User interface and application logic on the client
  - Persistence on the database server (data can be easily shared between clients)
  - Installation of the client required
  - Update of client can be complicated (distributed redeployment)
  - Export of data still problematic
- Result: Inadequate architecture for our purposes

Example – Reservation system – 2-tier architecture II?

- Web application (thin client)
  - User interface on the client (web browser)
    - No need to do installation
    - Change in the application means redeployment only on the server
  - Application logic and persistence on the database server
  - Application logic e.g. in stored procedures – logic is tightly bind to the database
  - Implies database which support such configuration (vendor lock-in)
  - Export of data
    - Automatically by scheduled stored procedures (scheduled jobs)
    - Special application on the database server
    - Manually in the web GUI by special user
- Result: Better than 2-tier desktop application but still some flaws

Example - Reservation system - 3-tier architecture I?



- Desktop application (thick client)
  - User interface on the client
  - Application logic on the application server
  - Persistence on the database server
  - Easier to switch to different database or use simpler database
  - Installation of the client still required
  - Performance of user interface can be slower than in 2-tier (application logic executed on the application server – network boundaries)
  - Better scalable than in 2-tier (application server can also cache common data shared by multiple clients without need to load them from DB)
  - Still need to solve update of client (user interface)
  - Export of data solved on the application server
  - Used in cases when you need advanced and fast GUI
- Result: 3-tier desktop application doesn't solve deployment issues

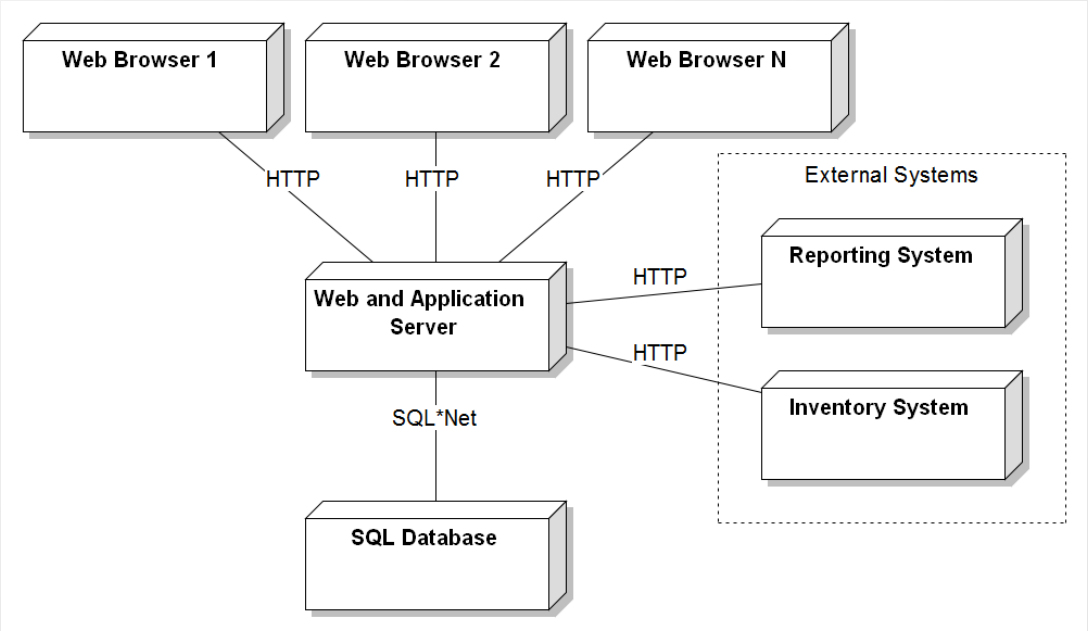
Example – Reservation system – 3-tier architecture II?

- Web application (thin client)
  - User interface on the client (web browser)
    - No need to do installation
    - Change in the application means redeployment only on the application (web) server
  - Application logic on the application (web) server
  - Persistence on the database server
  - Export of data
    - Special application (or just component) on the application (web) server
    - Manually in the web GUI by special user
  - Scales quite well
    - If weakest point is application server add additional server
    - If weakest point is database use clustered database (there are some limits
  - Standard how applications are build today (a lot of “support” on the internet)
- Result: 3-tier web application is the best for our needs

Example – Reservation system – Deployment diagram I

Possible deployment for intranet

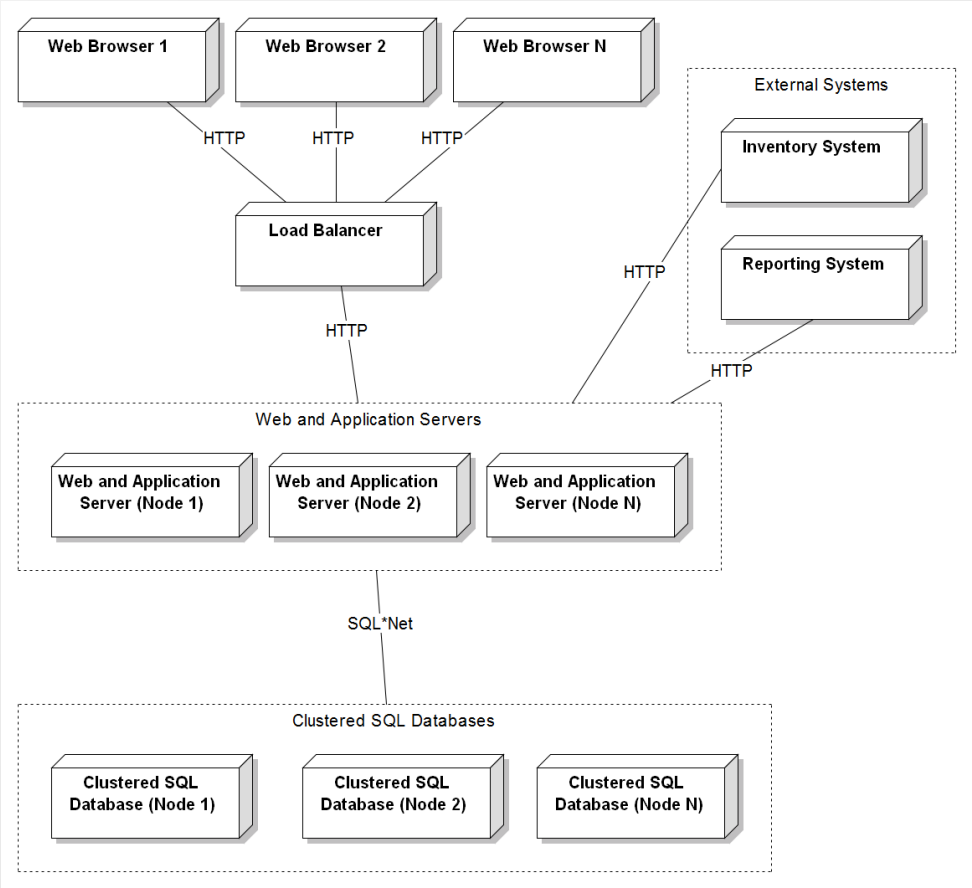
- User's need just standard web browser (no need for installations)
- For communication between clients and server just HTTP is used (we are in "secure" area)
- Web and Application server contains main part of the solution
- New version of the application means just redeployment on Web and Application (+SQL) server
- Communication with external systems is via HTTP
- For storing data standard SQL database is used



Example - Reservation system - Deployment diagram II

Possible deployment for big amount of clients

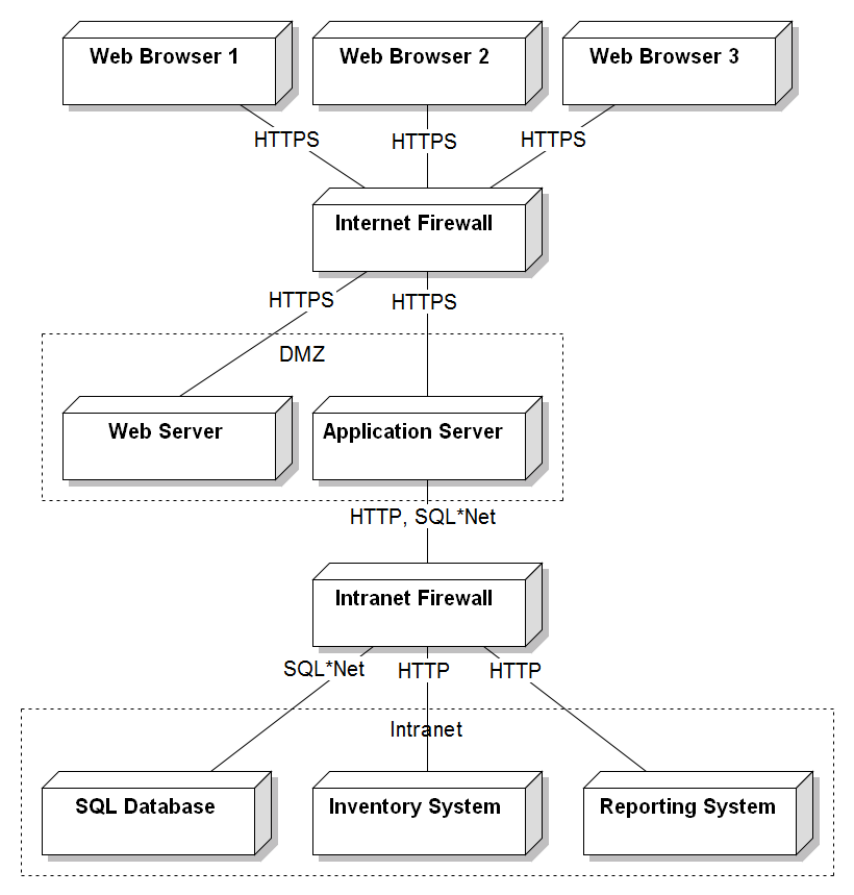
- Load balancer distributes requests to different nodes
- There are multiple web and application server nodes
- SQL database is configured to be clustered database on several nodes



Example - Reservation system - Deployment diagram for internet

Possible deployment for internet environment

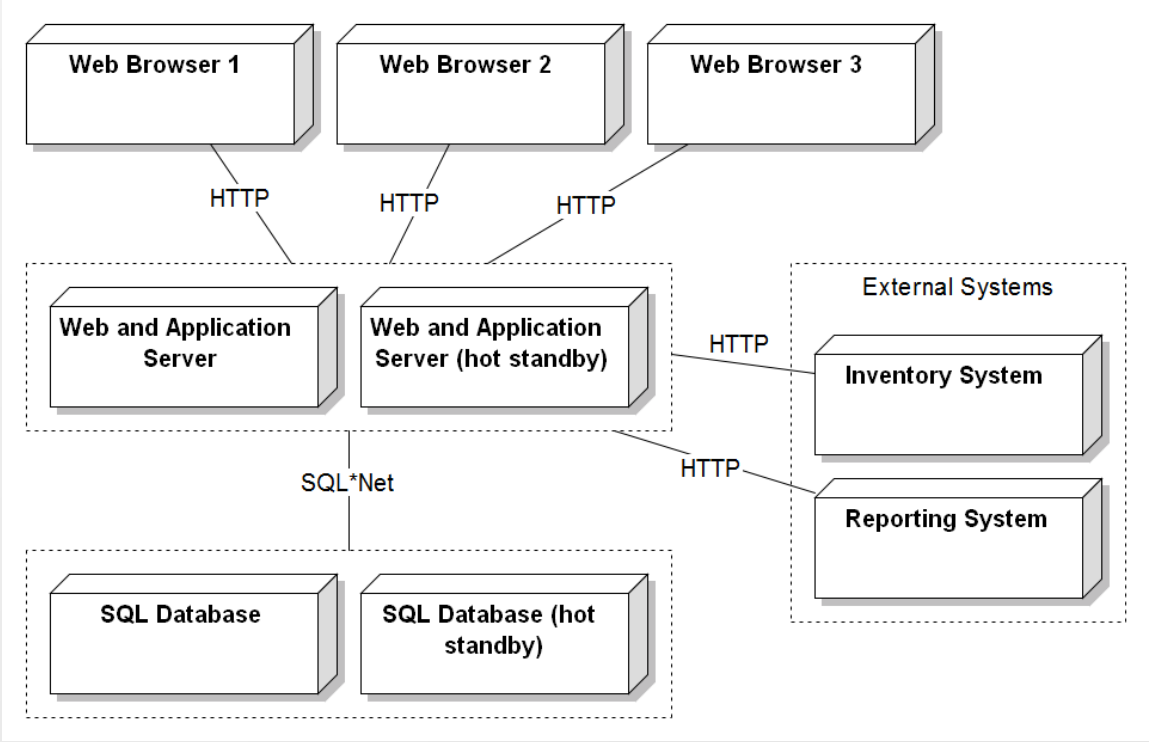
- Web browsers use HTTPS instead of HTTP
- Internet firewall restricts protocols just to HTTPS
- To increase performance static content (pictures, videos, static HTML pages, …) are handled on special web server node
- Intranet firewall restricts protocols to HTTP and SQL*Net and requests only from application server
- Communication in the intranet is just HTTP



Example - Reservation system - Deployment with redundancy

Possible deployment with redundancy

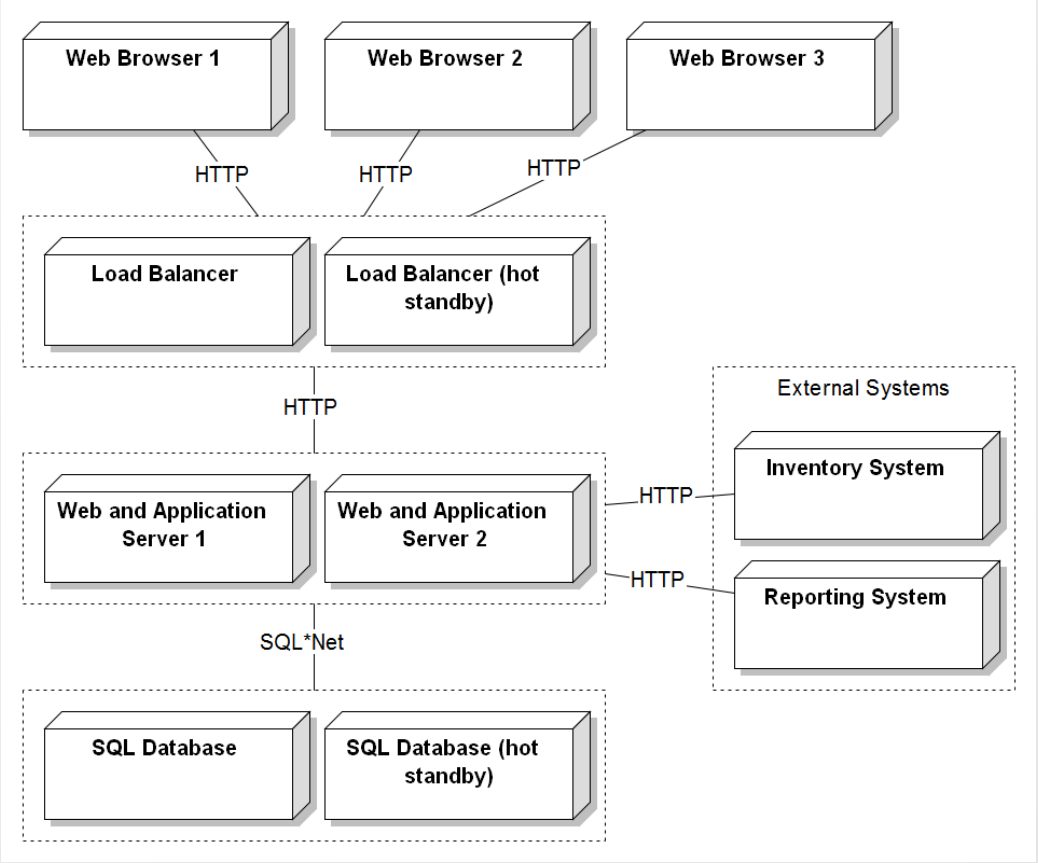
- Each critical node is backed up by the same node
- In case of failure (e.g. HW) second (standby) node will handle request
- Standby nodes add additional costs but do nothing in normal behavior
- Weak points are external systems which we cannot influence



Example – Reservation system – Deployment with load balancing redundancy

Possible deployment with load balancing redundancy

- Load balancer distributes requests either to Web and Application server 1 or 2
- Load balancer is backed up
- Web and Application Server must be stateless or load balancer must take into account user's session
- In two node deployment for Web and Application server one node must be able to handle all requests (in some decreased performance)
- Standard database cannot be easily load balanced. Often they are weak point in scalability



Recommendations and what you have to think about I

- For majority of new EIS applications use 3-tier (n-tier) web based architecture
- Backup critical systems (calculate losses in case of not functional system)
- Know expected number of user's
  - In the beginning it can be hard to guess especially for applications which will become popular
- Be prepared for increasing number of users
  - Cloud computing can help you
- Do load testing before system goes to productive
  - Only a few projects do this
- Be prepared to use your system from internet
  - You have to take care more about the security on the internet
- Be prepared for different user devices (standard PC, tablet, mobile)
  - There is increasing importance of mobile devices

Recommendations and what you have to think about II

- Prepare the architecture before any development starts
  - When real development starts it is too late to create the architecture
- Keep in mind all important non-functional requirements
- Create documentation and guidelines for developers and share the knowledge
  - Better is to make an architecture meeting than just telling to developers “here are documents and read them”
  - Do it continuously
- Setup tools which help you finding abnormalities in the architecture from code
- Do the code reviews to find “code smells”
- Adapt architecture through the lifetime to fit into new requirements
- Role of architect is not valid only in the beginning but through the whole lifetime of the project
  - A lot of projects starts with good architecture but degrade through the lifetime as requirements change

Different architectures examples I

Which architecture type (number of tiers, type of the client) do you recommend for following usages?

- Game on mobile device
  - 1-tier, thick client
- Game on mobile device with possibility to use multiplayer functionality and sharing game scores
  - 3-tier, thick client
- Application for managing business trips which must run on mobile devices and standard PCs
  - 3-tier, thin client (web application)
- Mobile application for collecting data from house construction in the field and reporting them to the headquarter (must work offline)
  - 3-tier, thick client

Different architectures examples II

- Management reporting application with advanced graphical interactive reports which must run on “any” device
  - 3-tier, thin client (web application with some technology which allows displaying interactive reports e.g. Flash or HTML5)
- Industry application for reporting whether conditions
  - 3-tier, thick client (embedded SW)
- News application aggregating data from different sources
  - 3-tier, thin client (web application)
- Project management application
  - 3-tier, thin client (web application)
- Computational intensive application (simulation of chemical processes)
  - 3-tier, thick client (special desktop application), distributed computing

Děkuji za pozornost.

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EVROPSKÁ UNIE esf

MINISTERSTVO ŠKOLSTVÍ, MLÁDEŽE A TĚLOVÝCHOVY

OP Vzdělávání pro konkurenceschopnost 2007-13

UNIVERSITAS MASARYKIANA BRUNENSIS

INVESTICE DO ROZVOJE VZDĚLÁVÁNÍ