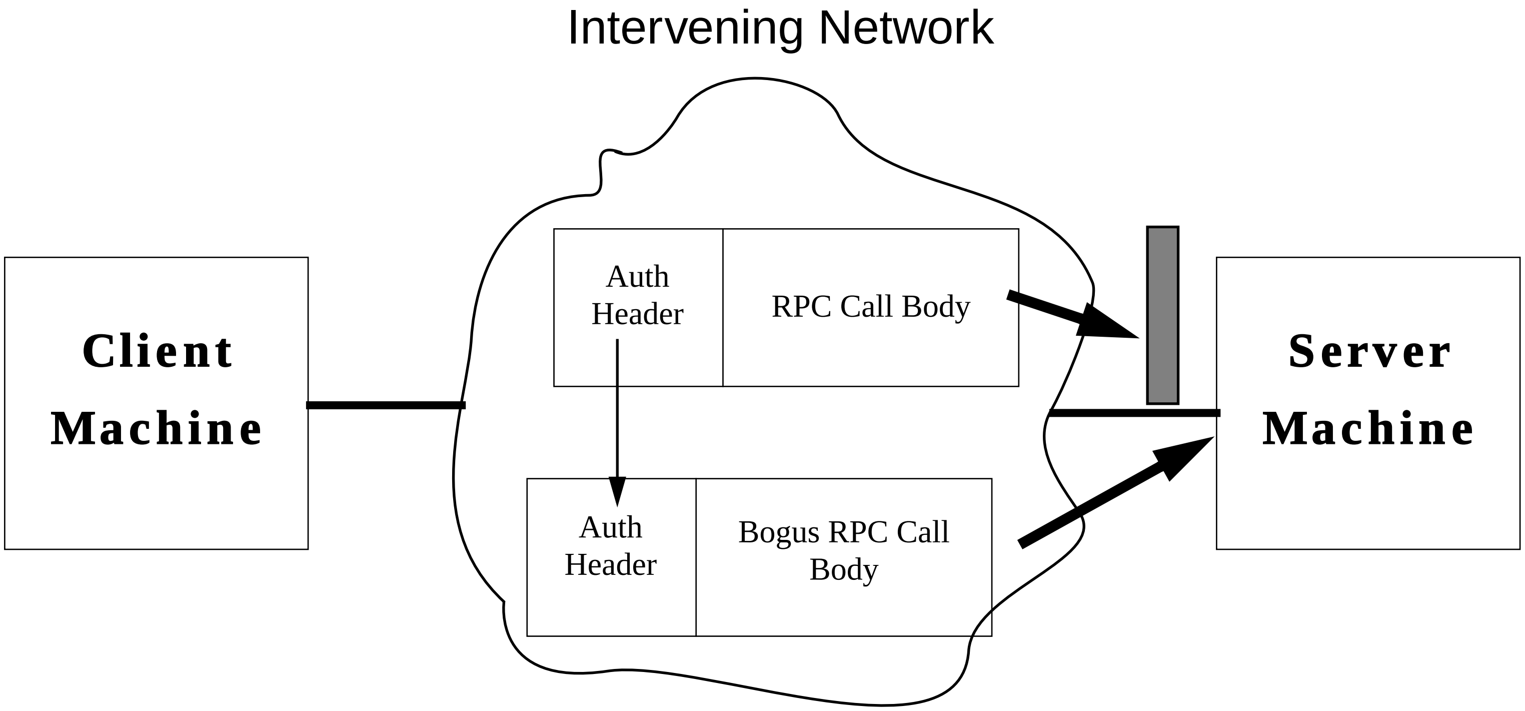
# CURRENT RPC SECURITY FLAVORS

- **AUTH_UNIX**
  - simple, fast, de-facto standard
  - trivial to defeat
- **AUTH_DES**
  - uses Diffie/Hellman public key algorithm
  - documented weaknesses(LaMacchia and Odlyzko, 1990)
- **AUTH_KERB**
  - uses Kerberos V4
  - missed market window to complete a product
  - documented weaknesses (Bellovin and Merritt, 1991)

# EXERCISING HINDSIGHT ON PAST APPROACHES

- **Flavors had designed in (unforeseen) limitations**
  - AUTH_UNIX had too few Unix group ids
  - AUTH_DES had too small a key size
  - neither AUTH_DES nor AUTH_KERB provided integrity/privacy
- **Adding a security mechanism required per application changes**
  - no notion of flavor or security mechanism independence
- **Security mechanism specifics had to be ported into kernel for NFS implementation.**

# INTEGRITY ATTACK



AUTH_DES and AUTH_KERB

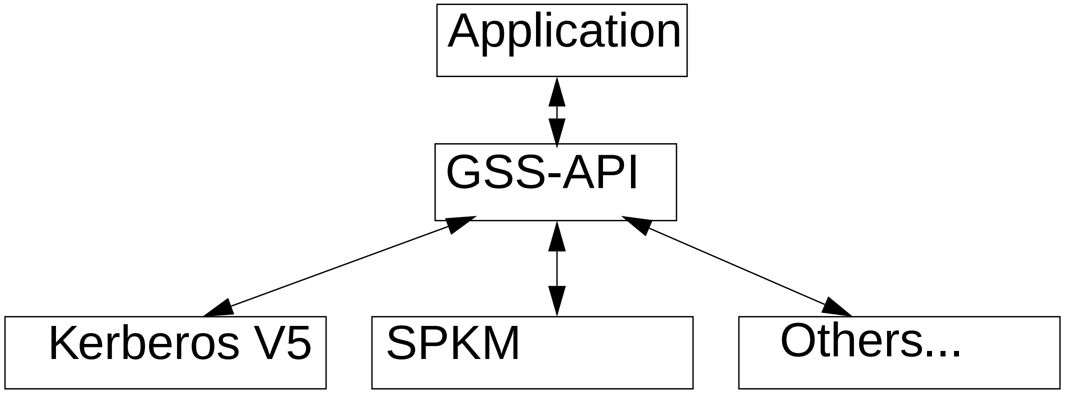
# REQUIREMENTS FOR A SOLUTION

- **Support multiple underlying security mechanisms**
- **Support all of Authentication, Integrity, Privacy**
- **Mechanism should be transparent to the application**
- **ISVs should be able to add new mechanisms**
    - Modulo U.S.A export control laws
- **Preservation of Binary and Source compatibility**
- **Use standards where possible**

**GSS-API has the above characteristics**

# GSS-API OVERVIEW

- **RFC 1508 describes the framework**
- **RFC 1509 describes the C language bindings**
- **Similar to TLI**
  - normalizes access to security mechanisms
  - like TLI, punts on generic naming issues



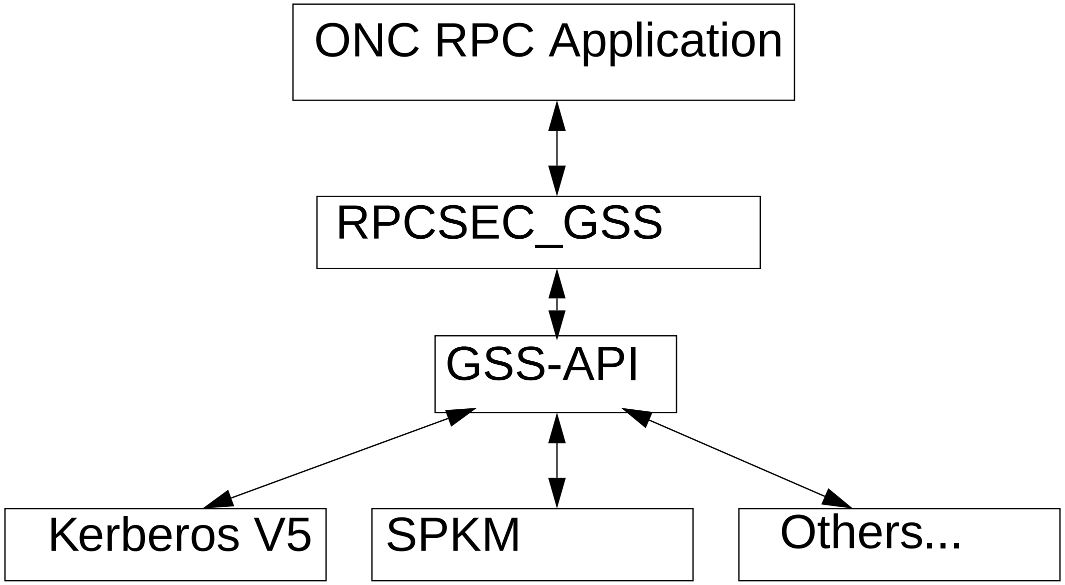
# GSS-API OVERVIEW

- **Binds authentication with mechanism**
- **Offers optional integrity or privacy**
- **Permits specification of Quality of Protection**
  - cryptographic algorithm used with integrity or privacy
- **Transport is the responsibility of application**
  - However, some support for channel bindings.
  - GSS-API primitives return tokens which are sent to application’s peer

  - However, some support for channel bindings.

# RPCSEC_GSS SECURITY FLAVOR

- **A new flavor that encapsulates GSS-API:**



- **Provides virtually all of the GSS-API interfaces to ONC application.**
    - punt on channel bindings

# API OF RPCSEC_GSS

## *Client side example:*

```
AUTH *rpc_gss_seccreate(
  CLIENT *clnt,          /* in */
  char *principal,       /* in */
  char *mechanism,       /* in */
  rpc_gss_service_t service_type, /* in */
  char  *qop,            /* in */
  rpc_gss_options_req_t
     *options_req,/* in */
  rpc_gss_options_ret_t
     *options_ret);/* out */
```

```
clnt -> cl_auth = rpc_gss_seccreate(clnt,
 “nfs@jurassic.eng.sun.com”,”kerberos_v5”,
 rpc_gss_svc_integrity,
 “GSS_KRB5_INTEG_C_QOP_DES_MD5”, NULL,
 NULL);
```

# API OF RPCSEC_GSS

## *Server side example:*

```
server_prog(struct svc_req *rqstp,SVCXPRT *xprt)
{
  rpc_gss_ucred_t *ucred;
  rpc_gss_rawcred_t *rcred;

  switch (rqstp->rq_cred.oa_flavor) {
  case RPCSEC_GSS:
    /* get credential information */
     rpc_gss_getcred(rqstp, &rcred,&ucred,NULL);
     if (!authenticate_user(ucred->uid, rcred->mechanism,
          rcred->qop, rcred->service)) {
               svcerr_weakauth(xprt);
               return;
     }
     break; /* allow the user in */
  default:
    svcerr_weakauth(xprt);
    return;
  } /* end switch */
...
}
```

# RPCSEC_GSS PROTOCOL

- **Session-based like AUTH_DES and AUTH_KERB**
- **Based on OpenVision’s AUTH_GSSAPI protocol**
- **Session has three phases:**
    - Context creation
    - RPC Data Exchange
    - Context Destruction

# RPCSEC_GSS PROTOCOL

## *Context creation request*

- Procedure number in call header set to NULLPROC
- AUTH header’s credential:

```
struct opaque_auth {/* credential */
  sec_flavor flavor; /* Set to RPCSEC_GSS */
  opaque body<400>; /* body encoded as rpc_gss_cred_t */
};
struct rpc_gss_cred_t {
    unsigned int version; /* set to 1 */
    unsigned int gss_proc; /* RPCSEC_GSS_INIT */
    unsigned int seq_num; /* ignored */
    enum service; /* ignored */
    opaque handle<>; /* zero length */
};
```

- AUTH header’s verifier is NULL on context create.

# RPCSEC_GSS PROTOCOL

## *Context creation request*

- **Call arguments don’t contain NULLPROC args, but instead:**

```
struct rpc_gss_init_arg {
  opaque gss_token<>; /* from GSS-API’s
                         gss_init_sec_context() */
  unsigned int qop;
  enum service; /*integrity, privacy, default, or none */
};
```

# RPCSEC_GSS PROTOCOL

## *Context creation response*

- **Response results don’t contain NULLPROC results, but instead:**

```
struct rpc_gss_init_res {
  opaque handle<>; /* context identifier */
  /* gss_major/gss_minor returned from GSS-API’s
     gss_accept_sec_context() interface */
  unsigned int gss_major;
  unsigned int gss_minor;
  unsigned int seq_window; /* maximum number of
      outstanding RPC requests for this context. */
  opaque gss_token<>; /* token from
         gss_accept_sec_context() */
};
```

# RPCSEC_GSS PROTOCOL

## *RPC Call*

- **AUTH header format:**

```
struct opaque_auth {/* credential */
  sec_flavor flavor; /* Set to RPCSEC_GSS */
  opaque body<400>; /* encoded as rpc_gss_cred_t */
};
struct rpc_gss_cred_t {
    unsigned int version; /* set to 1 */
    unsigned int gss_proc; /* RPCSEC_GSS_NULL */
    unsigned int seq_num; /* monotonically increasing */
    enum service; /* integrity, privacy, none*/
    opaque handle<>; /* context id from context create
      response */
};
```

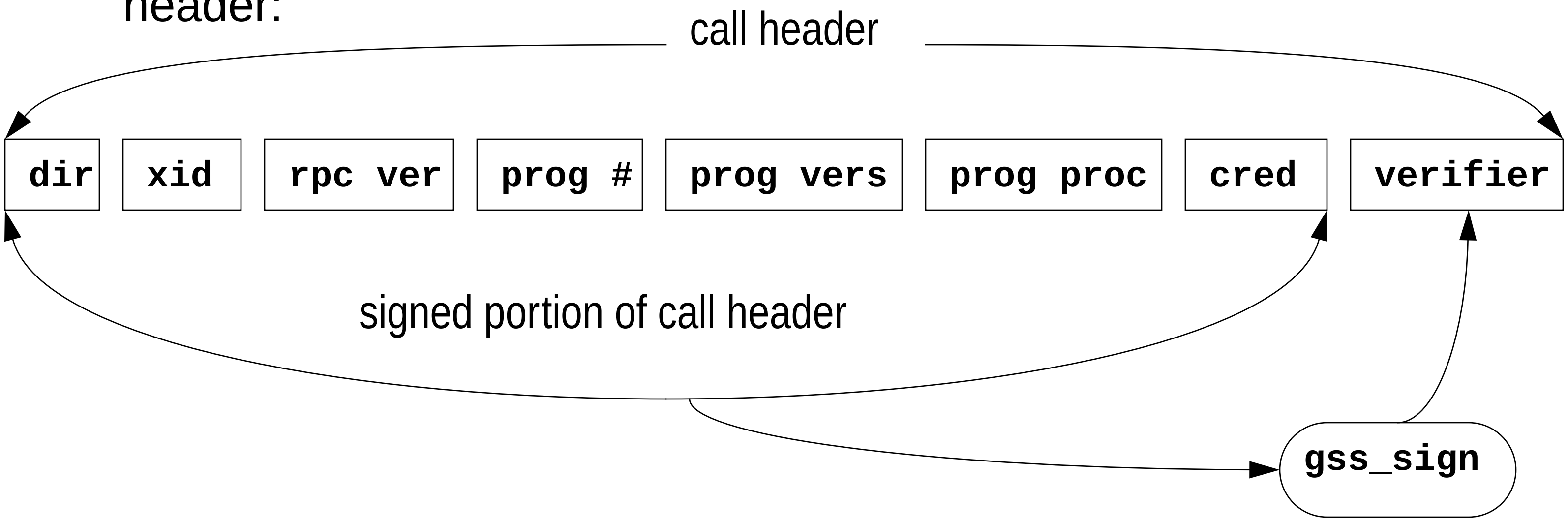
# RPCSEC_GSS PROTOCOL

## *RPC Call*

- **AUTH header format:**

```
struct opaque_auth {/* verifier */
  sec_flavor flavor; /* Set to RPCSEC_GSS */
  opaque body<400>;
};
```

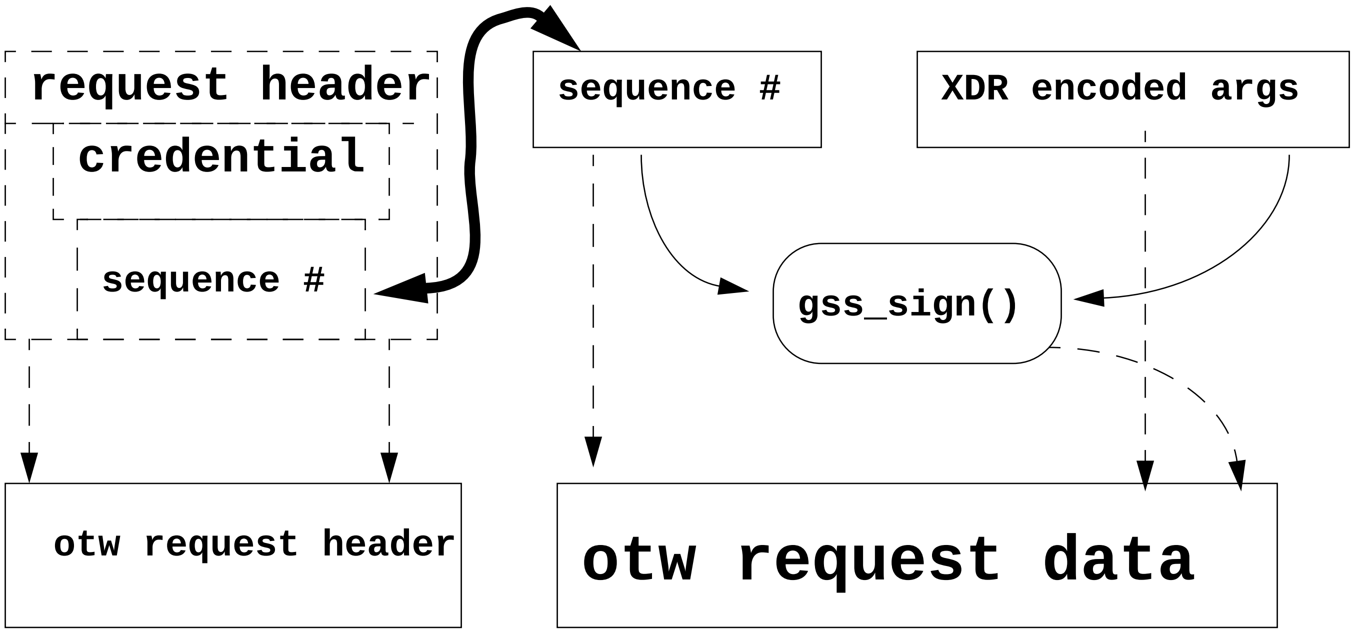
  - opaque_auth.body is set to gss_sign() (check sum) of rest of RPC call header:



# RPCSEC_GSS PROTOCOL

## *RPC Call*

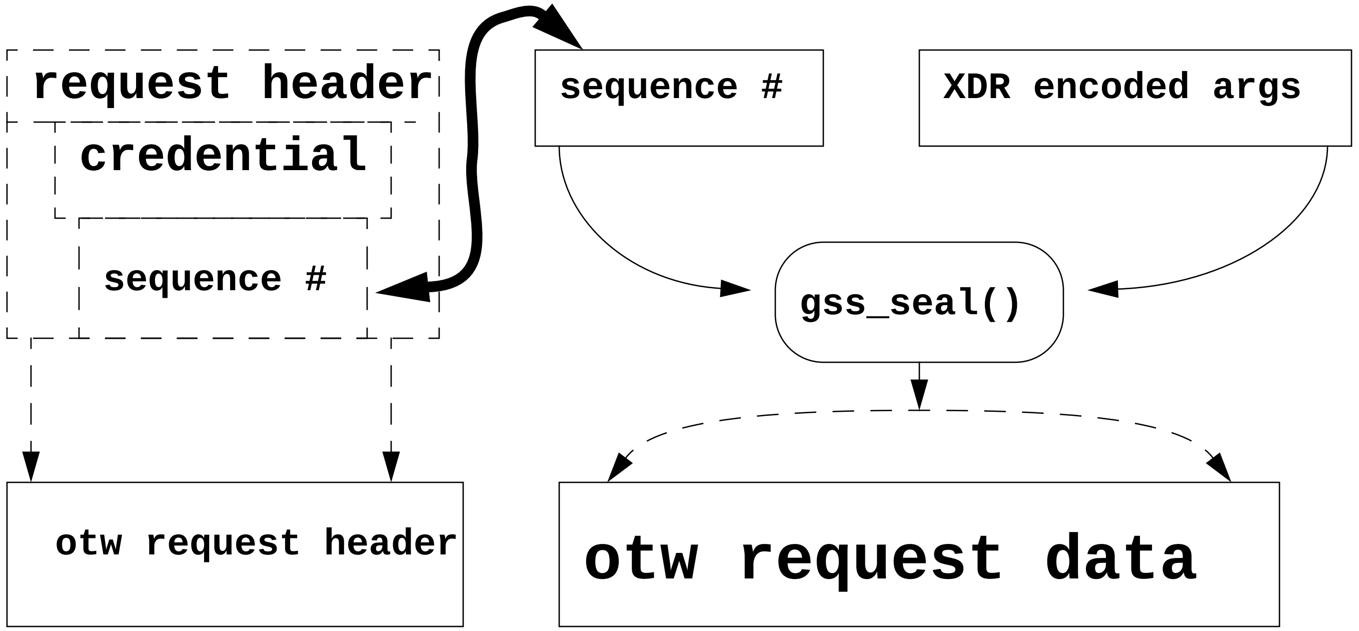
- **Integrity protected requests**



# RPCSEC_GSS PROTOCOL

## *RPC Call*

- **Privacy protected requests**



# RPCSEC_GSS PROTOCOL

## *Server processing of requests*

- **Server verifies**
  - version number of RPCSEC_GSS from cred
  - service specified in cred
  - context handle in cred
  - sequence number in cred
  - header checksum (gss_sign()) in verifier

# RPCSEC_GSS PROTOCOL

## *Server processing of requests*

- **Sequence number processing**
  - Server maintains WINDOW of sequence numbers
  - WINDOW starts from last sequence number seen and extends backwards.
  - WINDOW moves forward to the highest sequence number seen.
  - In case of integrity or privacy, the server will reject message if the sequence number in request body differs from that in cred.
  - requests with sequence #s below the range are silently discarded
    - **prevents reply attacks and problems with networks sending duplicates.**
    - **no danger of denial of service attack because creds are required for attacker to forge requests. Seq# check occurs after the other processing of the AUTH header.**

# RPCSEC_GSS PROTOCOL

## *Server replies*

- **Note that ONC RPC doesn’t have creds on replies, just verifiers.**
- **The verifier is a gss_sign() of the sequence number of the request.**
- **Integrity or privacy are specified on the call, the reply is encoded the same way.**

# RPCSEC_GSS PROTOCOL

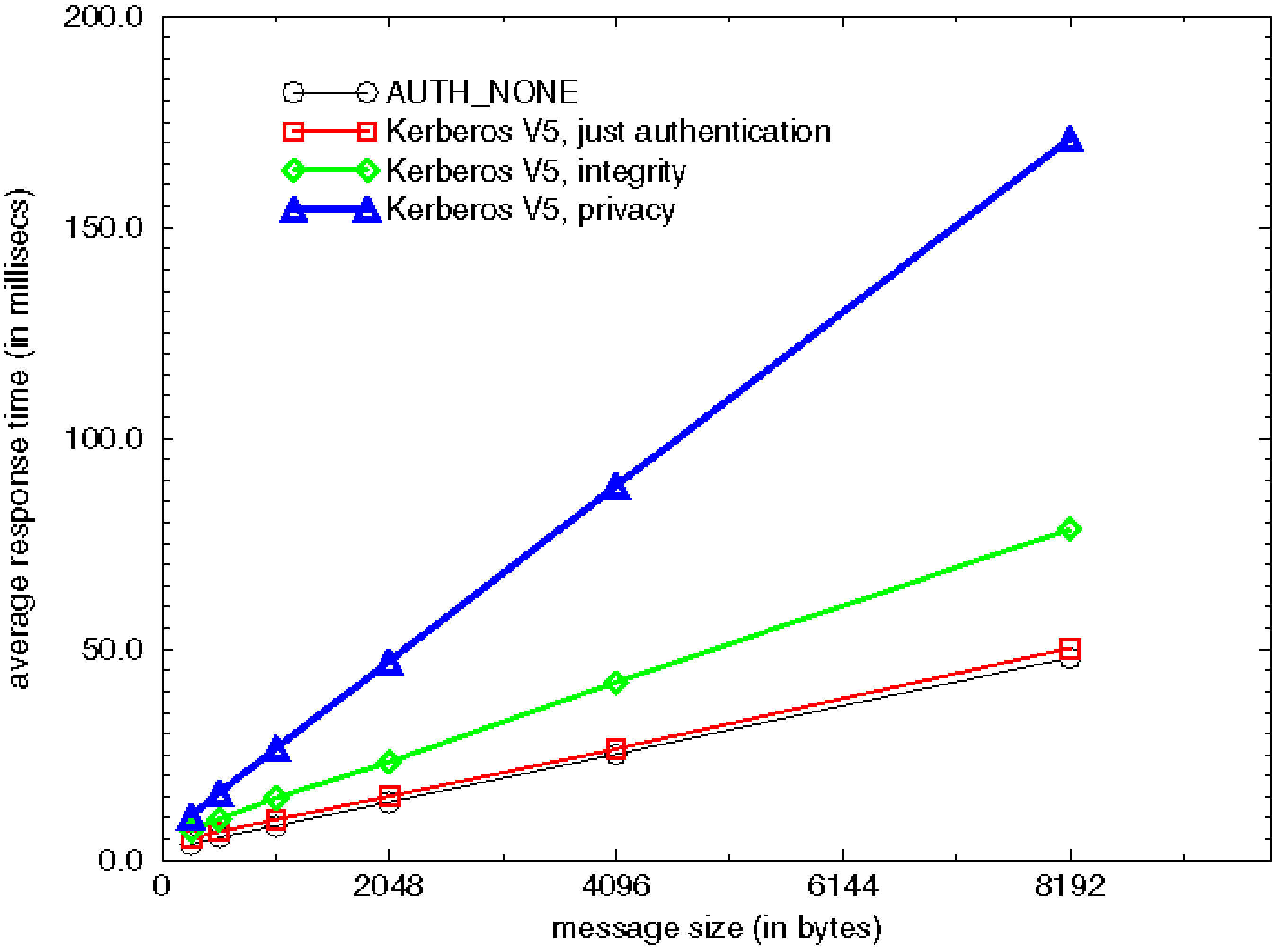
## *Context destruction from client*

- **Like a regular data call but:**
  - Procedure number set to NULLPROC
  - gss_proc in the credential set to RPCSEC_GSS_DESTROY

## *Reply to context destruction*

- **LIke a regular reply**

# RPCSEC_GSS PROTOCOL: Preliminary Performance


average response time (in millisecs)
message size (in bytes)
AUTH_NONE
Kerberos V5, just authentication
Kerberos V5, integrity
Kerberos V5, privacy